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# CONTRIBUTORS TO VOLUME LI

ALBEE, FRED H	289	GELLIORN, GEORGE	484	MACEachern, MALCOLM T	273
ARMSTRONG GEORGE F	138	GIBSON, WILLIAM	869	MACK, H C	476
BALFOUR, DONALD C	135	GLASER, MARK ALBERT	17	MAES, URBAN	700
BALLOU, A D	8	GOTTESMAN, J	667	MARTIN, FRANKLIN H	10
BARTLETT, WILLARD	217	GREENOUGH, ROBERT B	561	MASON, MICHAEL L	591
BARTLETT, WILLARD, JR	217	GRODINSKY, MANUEL	460	MATTISON, SAMUEL J	550
BAZIN, A T	565	GUTHRIE, DONALD	420	MAYES, H W	345
BEHREND, MOSES	717	GWATHMEY, JAMES T	190	MAYO, W J	3, 262
BENEDICT, EDWARD B	626	HAMER, H G	541	McCLURE, W L	208
BIRD, CLARENCE E	738	HARDIN, MAXWELL	145	MEIGS, JOE V	626
BLAIR, VILRAY P	81	HARBIN, R M	863	MERTZ, H O	541
BOLTON, W W	469	HARRINGTON, STUART W	504, 647	MILLER, C JEFF	557
BOURNE, WESLEY	356	HART, VERNON L	727	MILLS, RALPH G	545
BRAASCH, WILLIAM F	421, 494	HAYDEN, I PARKER	783	MONTGOMERY, ALBERT H	415
BROWN, ALFRED	141, 268, 429, 567, 744, 876	HEATHCOTE, REGINALD ST A	65	MONTGOMERY, THADDEUS L	469
BROWN, J B	81	HENDERSON, MELVIN S	561, 720	MUSSELL, J J	415
BRUGER, M	356	HENRY, ARNOLD K	65	NATZIGER, HOWARD C	17
BRUNN, HAROLD	115	HERBST, ROBERT H	213	NORDLAND, MARTIN	449
BUCKSTEIN, JACOB	109	HILLIS, DAVID S	852	NORTH, JOHN PAUL	183
CALLAHAN, JAMES J	387	HINMAN, FRANK	237	OLCOTT, CHARLES T	61
CAMPBELL, MEREDITH F	674	HOLLAND, WILBUR W	683	PACK, GEORGE T	749
CAMPBELL, WILLIS C	2381	HILMAN, ABRAHAM	409	PARSONS, ELOISE	196
CANTAROW, A	469	IASON, A H	76	PAUCHET, VICTOR	367
CHASE, WILLIAM H	31	JACQUES, LAWRENCE	823	PERLA, D	667
CLUTE, HOWARD M	136	JELSMA, FRANKLIN	537	PHANTUF, LOUIS E	500
CONLEY, ARTHUR H	387	JONA, J LEON	150	PHENISTER, D B	196
COTTRELL, JOHN C	731	JONES, DANIEL FISKE	208	POLLEY, HUGH J	213
CUBBINS, WILLIAM R	387	JUDD, E STARR	479	RADASCH, HENRI ERDMAN	42
CURTIS, GEORGE M	805	KANAVEL, ALLEN B	5	RAMSEY, FRANK B	352
DANNREUTHER, WALTER T	522	KARTAL, ST	99	ROBINSON, M R	321
DEAVER, JOHN B	520	KLEEGMAN, SOPHIA J	552	ROWLANDS, R P	844
DRETZKA, LEO	258	KUCH, SUMNER L	591	SCHOEMAKER, JAN	840
DREYER, N B	356	KREISELMAN, JOSEPH	361	SHEDDEN, WILLIAM M	783
ELIASON, ELDRIDGE L	183	KRETSCHMER, HERMAN L	404	SMITHWICK, R H	394
ELIOT, ELLSWORTH, JR	424	KUPF, JOHN H	798	SNOW, LAWRENCE C	252
FAULKNER, WILLIAM B, JR	115	LAHEY, FRANK H	227, 692	SOLOMONS, BETHEL	491
FISHBACK, F C	737	LARIMORE, JOSEPH W	810	SOUTTER, ROBERT	249
FLECKER, H	50	LASH, A F	55	SPEED, KELLOGG	854
FOSS, HAROLD L	264, 798	LEARMONTH, JAMES R	494	SPRUNT, DOUGLAS H	245
FRASER, JOHN	162	LEDERER, MAX	76	SPURLING, R GLEN	537
FRIEDBACHER, K	378	LITTLE, WENDELL D	352	STEIN, ARTHUR	856
GARLOCK, JOHN H	705	LOHNGIER, ANDREW STEWART	740	STEINER, MORRIS	76
GATTI, GEROLAMO	224	LUND, FRED B	266	STUEBNER, ROLAND W	169
GEIST, SAMUEL H	848	LUQUET, GABRIEL	367	TINAER, MARTIN B	563
		MACDONALD, RALPH	131	TORAL, FRANZ	856
				TREYES, NORMAN	749



ULLMAN, SALLA	345	WATKINS, RAYMOND I	125	WISE, WALTER D	748
UPSHAW, HARRY T	556	WEYHERELL, FREDERICK S	133	WRIGHT, WILLIAM	836
		WHITE, CHARLES S	361		
WAKELEY, CECIL P G	256	WHITE, J C	304	ZIEGLER, J M	667
WALTERS, WALTERMAN	711 836	WILSON, WILLIAM M	125	ZOLLINGER, ROBERT	145 873

# SURGERY, GYNECOLOGY AND OBSTETRICS

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NUMBER 1

## AN EXPERIMENTAL STUDY OF THE EFFECTS OF DEPRESSED FRACTURES OF THE SKULL

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THIS enquiry into the effects of depressed fractures of the skull was prompted by the widespread opinion that such depressions invariably should be elevated. It often is stated that untreated depressions cause progressive brain damage and lead to pachymeningitis, adhesions, areas of cerebral softening, and brain cysts. To such changes post-traumatic epilepsy, insanity, and psychoses are attributed. Our experience causes us to question the correctness of such views.

### HISTORICAL

Trephining for depressed fractures is an operation of antiquity (30). In the neolithic period, about 25,000 years ago, skulls were trephined. The operative mortality must have been exceedingly high. This operation was carried out also in ancient Egypt, as shown by a trephined skull described by Elliot Smith (30).

Of Greek surgery, in the period of 3800 to 500 B.C., there are no records. Without doubt, in the height of the Cretan civilization, 2000 to 1400 B.C., the Mycenaean civilization, 1500 to 1300 B.C., and the period of Homer, 1000 to 900 B.C., these operations must have been performed (4, 13).

The first important contribution to craniotomy surgery has been attributed to Hippocrates, 460 to 370 B.C. Hippocrates (18) did not favor

operation in cases of depressed or comminuted fractures of the skull, but left the bone to suppurate gradually, thus discharging itself. He felt that fractures with depression were not particularly dangerous unless the membranes were ruptured. Severe contusions and simple linear fractures caused a great amount of cerebral vibration and would not allow the noxious material to come out of the brain. These he perforated to relieve the tightness of the brain and to procure evacuation of extravasated blood.

The Roman surgeon, Heliodorus (35), 75 B.C., expressed the idea that, in all cases of depressed fracture, the bones should be elevated, and Celsus, 30 B.C., agreed with him. Celsus (7), a prolific writer, approved of removing all spicules of bone immediately, elevating all depressed fractures, and smoothing down all protruding bone edges. He incised the scalp to inspect the condition of the outer table and, if necessary, the adjoining bone was trephined to elevate the depressed area. A meningo-physor, an instrument designed for elevation, was used.

With some modifications, the ideas of Celsus held sway from 75 B.C. to 1811 A.D. Galen (35), 150 A.D., favored the use of gouges and the lenticular rather than the trephine. Orribasius (35), 325 to 403, and Paulus of Aegina (35), 625 to 690, offered no new ideas but merely expressed the opinions of the earlier surgeons.

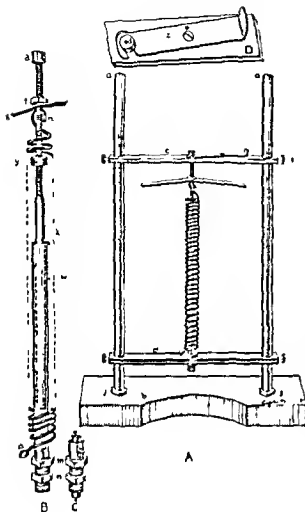


Fig 1 Fracture instrument

The three Arabian physicians, Rhazes (1735), 860 to 932, Albucasis (1735), 936 to 1013, and Avicenna (1735), 980 to 1036 though favoring the elevation of depressed fractures, were skeptical as to the results obtained therefrom. They must have realized that the mortality was very high, for they said that only skilled surgeons should undertake this procedure.

The celebrated Jewish physicians, Avenzoar (35), 1162, and his pupil Averrhoes (35), 1126 to 1198, also favored immediate elevation of depressed fractures.

Roger of Salerno (4), 1170, an important postclassical writer, believed it necessary to remove all the bone from areas of depression and to insert a fold of the finest linen with a feather, between the dura and the skull, so as



Fig 2 Type A depression. There is a depression of both the inner and outer table as well as of the underlying brain.

to clean the wound properly. In the opening of the fracture a piece of clean linen or silk was so placed that the edges were beneath the bone. Marine sponges, carefully cleaned and dried, also were used to absorb any exuding matter. The dressings were changed twice a day in the winter and three times a day in summer. The external wound was covered with a piece of linen soaked in white of egg, lightly wrung out over which a dressing of clean down was placed. The whole head then was bandaged with linen. It is very interesting to note the attention Roger gave to wound cleanliness.

Following the work of Roger of Salerno, Theodoric (4), 1205 to 1298, Walter of Aragon (4), 1250, and Mondeville (4), 1260 to 1320, also emphasized the necessity for the cleanliness of wounds. Theodoric, a pioneer in aseptic surgery, taught that pus was not necessary for the healing of wounds. Walter of Aragon believed that the skull should heal first and the skin last. Mondeville believed that all suppuration should be avoided.

The sixteenth, seventeenth, and eighteenth centuries brought forth many new and clearer theoretical considerations of brain damage. Ambrose Pare (34), 1509 to 1590, Jacobus Berengarius (4) 1728, Jean Louis Petit (36), 1674 to 1750, Percival Pott (38), 1713 to 1785, John Hunter (33), 1728 to 1793, Jean Dominique Larrey (26), 1766 to 1842, all favored the elevation of fractures. Berengarius operated to prevent the advent of symptoms. Jean Louis Petit felt that the operation of trephining was not mortal and gave exit to



FIG. 3. Type B depression. There is a more marked depression of both the inner and outer tables and the underlying brain than in Figure 2. The depression of the inner table is perfectly rounded and smooth. There is no evidence of spallation.



FIG. 4. Type B depression. Depression in the outer table has crossed the midline. There is a definite depression upon the surface of the brain. The inner table is again entirely smooth.

blood which had effused between the dura and bone. He thought that even though all patients did not fall into this category, there was no way in which they could be differentiated so all should be operated upon. Percivall Pott believed that the depressed bone was detrimental to the brain. In his opinion if the depression was slight and there were no urgent symptoms and no injury to the membranes, elevation was sufficient, but, if the force had been great, cerebral damage was certain and for this reason the whole piece of bone was to be removed to allow free drainage and to relieve brain pressure. John Hunter believed that depressions of the inner table were usually greater than those of the outer table and for this reason he advised elevation to prevent the possibility of any future harm. Larrey, the celebrated French military surgeon, considered immediate trephining indispensable.

Until the time of Abernethy (1) 1811 the surgeons were in fairly definite agreement

The entire nineteenth century was filled with divergent opinions and it was not until the twentieth century that surgical opinion was unified again. Abernethy, the successor of Hunter in London, believed that many cases of depressed fracture were operated upon unnecessarily, and he cited 5 cases wherein depressed fractures existed without derangement of cerebral function. He believed that the brain was not such a delicate organ that the least degree of pressure was highly injurious. He was unable to say whether remote effects occurred as he had not followed these patients for a long enough period of time. He could not conceive that pressure which caused no ill effects at the time of injury should produce injurious effects afterward, particularly when the brain had adapted itself to an altered size and shape. If symptoms of inflammation arose, he advised elevation to promote drainage.



FIG. 5. Type C depression. The depression of the inner and outer tables as well as of the underlying brain is more marked than the previous figures. Again the absence of spallation is noted.



FIG. 6. Type D depression. The depression upon the outer table is well circumscribed. It may be noted that the inner table is spalled and that this spall has traumatized the brain.



Fig. 7. Rabbit No. 56, 24 hours after fracture. Nissl toluidin blue. There is a hemorrhagic area extending from the cortex to the corpus callosum. Polymorphonuclear leucocytes, mononuclear cells, and red blood cells are present. The depressed area may be noted on the surface of the brain.

The French school of this period favored non operative treatment in simple depressed fractures, except when the symptoms of compression pointed to the depressed bone as their origin.

Thus two divergent views were held, one group favoring the elevation of depressed fractures and the other disagreeing.

Sir Astley Cooper (8) in 1839 was of the opinion that the cause of compression was the extravasation of blood, depression of bone and matter. He was the first to experiment upon the brains of animals. He applied digital pressure to the brain of a dog, noting that the greater the pressure, the slower the pulse, that with slight pressure pain and irritation were produced and that coma followed greater pressure. Upon release of this pressure the dog entirely recovered. It was his belief that the mischief of depression was not always immediate. If an open wound was present he operated immediately, but if there was no wound, the onset of symptoms was awaited.

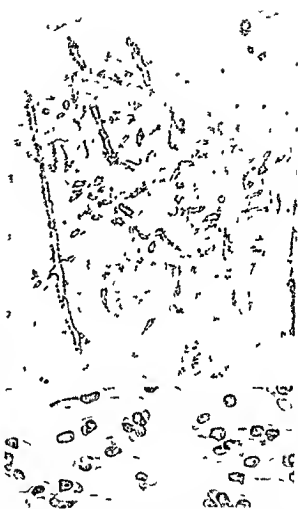


Fig. 8. Rabbit No. 2, 4 days after fracture. Nissl toluidin blue. In the subcortical area new blood vessel formation has occurred, as well as glial proliferation. The insert shows the glial cells highly magnified.

It frequently happened that there was considerable depression of the external table with no damage to the internal table. Upon these patients he did not operate. Guthrie (15) 1842 elevated depressed fractures if they were over the parietal lobe, for he had seen patients whose symptoms cleared up immediately following this procedure. Thompson (9) 15 and Hennen (9) 15, 16 agreed with this view.

Laurie (18 p. 361) 1856 felt that all depressed fractures should be operated upon early to prevent serious consequences rather than await their development. In 1877,

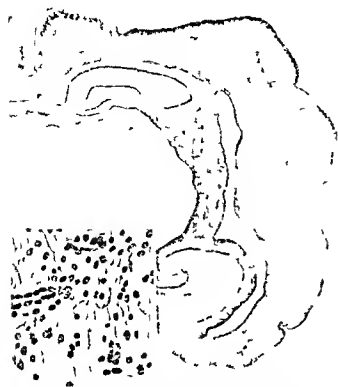


Fig 9. Rabbit No 44, 6 months after fracture. Nissl toluidin blue. There is an area of necrosis in the subcortical area above and lateral to the corpus callosum. The ventricles may be noted as well as the depressed portion of the brain. The insert shows the large vacuolated glial cells.

Robert Hudson (23) wrote his interesting paper in which he lamented the fact that, since the paper by Abernethy, trephining of depressed fractures had gone out of vogue. He fully realized the seriousness of the operation in London hospitals in which the mortality caused by pyæmia was very great. This he attributed to the septic atmosphere of the London hospitals. He gave the operative mortality as follows: Guy's Hospital, 51 of 67 operations, St. Thomas' Hospital, 3 operations and 3 deaths, St. George's Hospital, 13 deaths in 16 operations. In Redruth, Hudson said, trephining still was done, and the mortality was very low owing to the purity of the atmosphere which was daily swept by the Atlantic breezes.

In 1867 Lister (27, 28) delivered his celebrated lecture on asepsis before the British Medical Association in Dublin. The reduction of operative mortality and the fact that many sequelæ of non-elevated fractures were demonstrated led to the return of the operative



Fig 10. Rabbit No 28 8 months after fracture. Nissl toluidin blue. The area of necrosis is superior to the corpus callosum. The tip of the lateral ventricle may be seen. Upon high power gliosis and nerve cell degeneration are visible through the cortex and subcortical area.

trend. During the latter part of the nineteenth century, there was still a variance of opinion as to the subject was repeatedly discussed.

Holmes (14), in 1881, believed that depressed fractures should not be elevated upon and, agreeing with him in this, Hewett (14, 19), 1881, Kinkor (20), Sands (42), 1883, and Nancroft (21), 1883, believed that, if the elevation of the fracture should be elevated, the symptoms were not caused by the elevation of the bone, but by the effusion of blood into the brain trauma. Sands hesitated to elevate a simple into a compound fracture. (14) believed it better to leave a depressed fracture embedded in the brain than to elevate it, and irritation by injuring the brain tissue. Many attempts at removal have been made, but that elevation could not prevent the

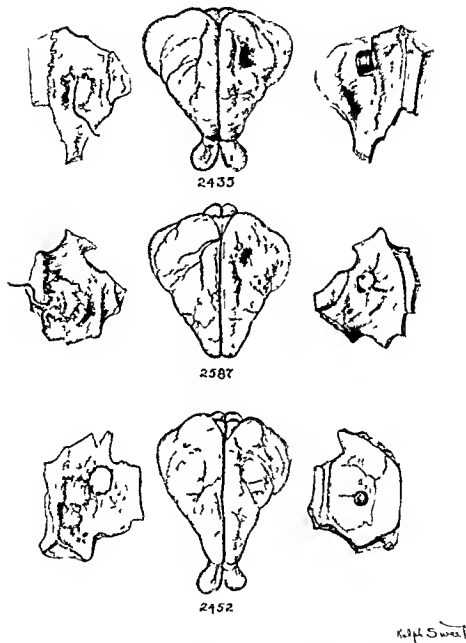


FIG. 11. Depressions of the brain. Beads inserted between the dura and skull resulted in marked cerebral depressions. The appearance of the outer table may be noted as well as the position of the bead in the inner table. These beads were held firmly in position by fibrous tissue growth.

damage caused by the depressed bone and felt that, for this reason, it was entirely unnecessary.

Levis (14), 1882, Gunn (14), 1882, Gross (14), 1882, Briggs (5), 1884, Roberts (40), 1884, Horsley (20, 21, 22, 28, 29), 1888, Keen (24),

1888, MacCewen (29), 1888, Agnew (2), 1891 and von Bergmann (43), 1890, believed that fractures should be elevated but that certain limitations should be placed upon each case. Levis believed concussion could not be differentiated from compression and felt that the

depth of the depression should be used as the criterion for operation. Gunn thought that all depressed fractures, whether simple or compound, should be elevated if it seemed probable that the inner table was depressed. Gross said that, if the depressions were moderate, they should be left alone, however, if there were symptoms indicative of depressed inner table, operation should be performed. Briggs agreed with Gross and Gunn. Horsley felt that all cases of depressed fracture could not be benefited by elevation after traumatic epilepsy had occurred but advised that, in all early cases, the depressed fracture should be operated upon to prevent epilepsy. In this opinion, Macewen, Agnew, and von Bergmann concurred. It now may be noted that the elevation of depressed fractures has taken on a definite purpose—that of preventing late results. All have agreed that, after these late symptoms have arisen, operative interference is of little value.

The twentieth century writers are unanimous in the foregoing opinion but their ideas as to the definite cause of these post-traumatic symptoms are still extremely hazy. Charles Phelps (37), in 1900, Crisp English (12), 1904, Pearce Bailey (3), 1906, E. Krause (25), 1909, Keen (10), 1915, B. Rawling (39), 1919, Charles Kahlke (32), 1920, Butler (6), 1921, Eagleton (11), 1921, and Ernest Sachs (41), 1922, are among the writers upon this subject.

With fractures which have lacerated, torn, or penetrated the dura and cortex, one expects to find varying degrees of change such as thickening of the meninges, adhesions, scars and degeneration of the cortex, and such has been our experience. If the dura is opened, some evidence of injury to the cortex may be apparent even following simple depressions. However, such changes are not always present, on several occasions we have found a normal dura beneath such a depression. Opening the dura revealed no discernible pathological change. The dura was not thickened, the leptomeninges were of normal appearance and not adherent and the color and circulatory condition of the brain cortex seemed normal. Such negative findings were noted not only in recent simple depressions but also in some of those of several years' standing.



Fig. 12 This is a series of skulls showing the relation of the damage of the outer table to the inner table. F 38 shows a well rounded depression of the outer table with fragmentation of the inner table. This may also be noted in F 2314. F 29 demonstrates a circumscribed depression of the outer table with a well rounded depression of the inner table.

Such experiences led us to question the wisdom of our operative intervention and prompted an enquiry into the relation of depression to changes in the brain. Are pathological changes, when found, the direct effect of the trauma or are they caused by the continued depression and in what way may these changes be modified by removal of the depression?

In an endeavor to establish a solution of this problem, the following experimental work was outlined: a series of depressed fractures were to be produced in rabbits and, at varying intervals of time following fracture, the brains were to be studied. As a control, depressed areas of dura and brain were produced in other rabbits by the insertion of glass beads between the dura and the skull.

#### OUTLINE OF EXPERIMENTAL WORK

The conduct of this experiment necessitated

1. Procuring a device which would produce identical depressed fractures in a series of animals.

2. (a) Pathological studies of the brains of animals at varying periods of time after the receipt of a depressed fracture. (b) Comparison of such changes with those produced by a depression not associated with a blow.



TABLE I—TYPE A

Animal No	Weight Kilos	Sacrificed at	Pathological changes	
			Cross	Microscopic
74	2.1	3 hours	Very slight hemorrhage beneath the pia. Slight flattening over area of depression.	Evidence of hemorrhage in the meninges, a slight hemorrhage over the cortex with a slight degree of edema.
73	1.0	6 days	Slight flattening over area of depression.	No pathological change.
8	3.6	6 days	Dura adherent to bone, but appeared normal. In the region of fracture was a slightly discolored area with a slight depression. Vessels were slightly dilated on the injured side.	No pathological change.
6	3.2	7 days	Slight flattening over area of depression.	No pathological change.
72	2.4	7 days	Slight flattening over area of depression of bone.	No pathological change.
14	1.7	8 days	Vessels on the injured area appeared slightly dilated. Slight flattening over the area of depression of bone.	No pathological change.
20	2.3	10 days	Slight area of depression.	No pathological change.
6r	2.0	12 days	Slight flattening over area of depression of bone.	No pathological change.
25	2.6	26 days	Vessels on the injured side slightly dilated. Slight flattening over the area of depression of bone.	No pathological change.
41	4.5	2 months	Slight brownish green area of fracture with the vessels on the injured side slightly contracted. Slight flattening over area of depression of bone.	No pathological change.
32	3.5	2 months	Slight flattening over area of depression of bone.	No pathological change.
26	2.3	6 months	Slight flattening over area of depression of bone.	No pathological change.
33	2.1	8 months	Slight flattening over area of depression of bone.	No pathological change.
39	3.3	9 months	Slight flattening over area of depression of bone.	No pathological change.
17	2.3	12 months	Slight flattening over area of depression of bone.	No pathological change.
55	2.7	12 months	Slight flattening over area of depression of bone.	No pathological change.

3 (a) Study of the brains in which a localized depression was produced by the extradural insertion of a small foreign body (bead). (b) Comparative study of a group in which such depressions had been produced and later relieved after varying periods.

#### APPARATUS

In order to produce experimentally a series of similar simple depressed fractures in animals it was necessary to devise an instrument by which the same traumatic force and the same depth of cranial depression could be produced on each occasion. Figure 1 shows the instrument devised for this purpose. This instrument consists of an iron plunger *c* with a rounded tip, which travels in the cylinder

*u*. The cylinder *u* is permanently attached to the cross beam *c* by the nuts *n* and *m*. The force is regulated by the spring *k* and is directly proportional to the stretch of the spring. This stretch may be varied and is controlled by the distance between the two cross beams *e* and *e*.

By trial the required force was determined. This was 10.5 inches of spring stretch. As the traumatic force had little to do with the depth of depression, the length of protrusion of the plunger *c* next had to be ascertained. This was five eighths of an inch. Set screws, *v* and *s* hold the plunger at this position.

Rabbits were used as experimental animals. The head was shaved and the rabbit was anesthetized. The head was placed upon the

base, *b*, with the neck fitting into the circular indenture. The base of the cylinder, *z*, was placed directly in contact with the rabbit's skull to one side of the midline and three-quarters of an inch from the occipital protuberance. The cross beam, *c-1*, was firmly screwed at the level thus obtained. The cross beam, *c*, was then raised so that the distance between *c-1* and *c* was 10.5 inches. The plunger was locked into position by the trigger, *x*. With the release of this trigger, the plunger was forced downward, through the cylinder, *w*, with a traumatic force equal to 10.5 inches of spring stretch and striking to a depth of five-eighths of an inch.

#### EXPERIMENTAL PRODUCTION OF DEPRESSED FRACTURES FOR PATHOLOGICAL STUDIES

Early in the course of these experiments it was found that the skulls of different rabbits varied in strength, and for this reason the depth of depression of the inner table varied. It was then necessary to classify these rabbits into various groups depending upon the depth of depression. This classification was determined entirely by the autopsy findings and was as follows:

Type A—very slight rounded depression without dural injury

Type B—marked depression without dural injury

Type C—greater depression than type B without dural injury

Type D—severe depressions with comminution, dural and brain laceration

Following fracture, all the animals except a few in the type D class rapidly recovered. There was no evidence of any clinical symptoms and all the animals appeared entirely normal. These animals were then sacrificed at varying intervals, the groups being tentatively determined by the palpation of the depressed area. The brains were then examined, both grossly and microscopically, for evidence of pathological change.

Type A (Fig. 2) demonstrates the slight depression in the inner and outer tables of the skull and upon the surface of the brain. There was no evidence of spiculation.

Table I represents a protocol of the 16 rabbits placed in this series. Upon study of

this table, it will be noted that these animals were sacrificed at periods from 3 hours to 12 months after the injury. In all of these cases there was a slight definite depression upon the surface of the brain. Only one animal presented any evidence of intracranial damage and this consisted of a slight surface hemorrhage. This animal was sacrificed at 3 hours. There was no evidence of late pathological change in any.

The illustrations of Types B and C (Figs. 3, 4, and 5) show the increased depth of fracture and brain depression. It may be noted that the depression in the brain is much greater than in type A.

Table II represents a protocol of 31 rabbits which comprise this series. A study of Table II shows that these animals were sacrificed at periods of time from 30 minutes to 9 months after fracture. In each there was a definite deep depression upon the surface of the brain and there was no spiculation of the inner table. Gross examination of these brains did not reveal any definite pathological changes, but microscopic examination presented some very interesting facts. The pathological changes shown varied with the time since injury.

For a comparison of the brain damage and the evidences of repair, three groups may be considered: Group I, acute traumatic—one-half hour to 30 days; Group II, interval period—30 days to 90 days; Group III, late pathological changes—90 days to 9 months.

Group I. In this group there were 15 rabbits, sacrificed from one-half hour to 30 days after fracture. All the evidence of acute trauma with the resulting repair was present. The meninges showed definite hemorrhage, with the presence of red blood cells, leucocytes, eosinophiles, and small mononuclear cells. Macrophages were present also, as well as were dilated, engorged, and ruptured blood vessels.

Within the brain substance were varying degrees of hemorrhage, from slight subpial hemorrhage to a large area of hemorrhage which extended from cortex to ventricle. The cellular infiltration consisted of red cells, polymorphonuclear leucocytes, mononuclear cells, some of them vacuolated and others containing brownish pigment. Many fat laden

TABLE II—TYPE B AND C

Animal No	Weight Kilos	Sacrificed at	Pathological changes	
			Gross	Microscopic
60	2.5	3 1/2 hour	Vessels over the area of depression were dilated the dura was intact. Definite flattening over area of depression	Marked extravasation of blood beneath the pia. The small vessels were ruptured. This extended only over the area of depression and was well localized. There was evidence of edema.
63	2.5	3 1/2 hour	Same as rabbit No. 60	Same as rabbit No. 60
56	2.0	24 hours	Same as rabbit No. 60	The hemorrhage was more severe than in rabbit No. 60. It extended deeply into the brain substance as far as the ventricular wall. The edema was more marked.
56	2.0	24 hours	Same as rabbit No. 60	Marked congestion of the vessels with some chromatin degeneration. The cellular infiltration consisted of practically all red cells very few leucocytes and some mononuclear cells.
3	2.7	4 days	Same as rabbit No. 60	Subdural hemorrhage was present. There was also extravasation of blood to the ventricular wall. One vessel at the marginal area showed perivascular infiltration of small round cells. Edema was marked and there were many large mononuclear cells present, some of them were vacuolated and some contained brownish pigment. The capillaries were very distinct in the center but at the border line they were suggestive of endothelial proliferation. Many fat laden cells were present in and about the hemorrhagic area. The nerve cells were in a stage of chromatolysis. The glial cells were swollen and were in various stages of degeneration. There was a slight tendency to glial reaction. Particularly in one part there was a definite zone of gliosis consisting almost entirely of glial nuclei. Macrophages were present in large numbers. In the meninges were also many small mononuclear cells containing pigment. The macrophages were present here also but not in so great numbers as in the brain.
7	3.4	7 days	Over the area of depression upon the surface of the brain was a discolored region	In this brain was noted a lessening of the number of large macrophages and a great decrease in the red cells but with an increase in the number of mononuclear cells. A glial reaction was still present but this was much less than in rabbits sacrificed after four days.
3	2.9	7 days	No evidence of injury on the surface of the brain	Hemorrhage within the meninges and pial layer were found in rows along the vessels. There were a number of eosinophilic cells in the region of the hemorrhage.
62	3.0	7 days	Same as rabbit No. 7	Same as rabbit No. 7
18	3.0	9 days	Area of depression well localized	Same as rabbit No. 7
33	2.3	12 days	Area of depression well defined slight discoloration on surface of depression	No pathological change
43	3.3	13 days	Area of depression well defined	Pathological changes very similar to those of rabbit No. 7 but fewer signs of active damage. Eosinophils more abundant.
13	3.5	20 days	Area of depression well defined	More marked absorption and regeneration of tissue.
46	3.4	24 days	Area of depression well defined	No pathological change
31	2.5	28 days	Area of depression well defined	No pathological change
30	2.3	30 days	Area of depression well defined	Showed a slight persistence of old hemorrhage. There seemed to be gradual absorption.
4	3.0	34 days	Area of depression well defined. Vessels slightly dilated on exposed side	No pathological change
34	2.5	34 days	Area of depression well defined	No pathological change
60	2.5	35 days	Area of depression well defined	No pathological change
21	2.3	38 days	Area of depression well defined	No pathological change
40	3.5	60 days	Area of depression well defined. Depressed area somewhat whiter in color than remaining brain	No pathological change
42	3.5	77 days	Area of depression well defined. Slight grayish of cortex over injured area	No pathological change
45	4.0	90 days	Area of depression well defined	Deep in the brain substance above the corpus callosum was a well marked area of necrosis with edema and vacuolated cells. Some of the cells were degenerated chromatinly, it was present in the nerve cells and very few glial cells were visible. There were fat containing macrophages.

TABLE II—Continued

Animal No	Weight Kilos	Sacrificed at	Pathological changes	
			Gross	Microscopic
38	5.4	90 days	Area of depression well defined	Same as rabbit No. 45
29	2.1	95 days	Area of depression well defined	Same as rabbit No. 45
43	4.3	97 days	Area of depression well defined	Same as rabbit No. 45
37	4.5	5 months	Area of depression well defined	Same as rabbit No. 45
36	4.5	6 months	Area of depression well defined	There was an area of necrosis against the corpus callosum with many gitterzellen and glial cells. Between the cells there was a granular amorphous substance especially in the outer part of the area. Surrounding the necrotic region there was a glial proliferation and a few scattered gitterzellen. Large reacting glial cells were present about the area of necrosis. Between the cortex and this area of necrosis there was an increase of irregularly distributed small glial cells. A few of the nerve cells showed chromatolysis.
50	3.0	6 months	Area of depression well defined	Same as rabbit No. 36
44	3.5	6 months	Area of depression well defined	Same as rabbit No. 36
28	2.2	8 months	Area of depression well defined	Area of necrosis was extending nearer to the cortex than in the previous rabbits.
49	3.5	9 months	Area of depression well defined	Area of necrosis extending nearer the cortex.

TABLE III—PRESSURE DEPRESSED FRACTURES

Animal No	Weight Kilos	Sacrificed at	Pathological changes	
			Gross	Microscopic
23	2.3	24 hours	Area of depression defined	No evidence of pathological change
64	2.7	8 days	Area of depression defined	No evidence of pathological change
27	2.1	20 days	Area of depression defined	No evidence of pathological change
19	2.3	2 months	Area of depression defined	No evidence of pathological change
59	2.5	4 months	Area of depression defined	No evidence of pathological change
38	2.5	12 months	Area of depression defined	No evidence of pathological change

cells were present in and about the hæmorrhagic area. Macrophages were present in great abundance. The vessels showed a perivascular infiltration of round cells, and there were gitterzellen in rows along them. At the border line between the normal brain structure and the injured area, the capillaries were swollen suggesting endothelial proliferation. The nerve cells were very often in the stage of chromatolysis. The glial cells were swollen and were in various stages of degeneration. In other areas there was a definite gliosis (Edema was marked throughout (Figs 7, 8).

*Group II* This series comprised 6 rabbits, sacrificed at intervals from 34 to 90 days. No gross pathological changes were present. The only microscopic evidences of pathological change were the presence of occasional pig-

mented cells, the remains of early hæmorrhage. It can be noted that within this period of time, the early evidences of trauma disappeared.

*Group III* This group of animals consisted of 10 rabbits sacrificed at intervals varying from 90 days to 9 months. Again there were no gross evidences of pathological change. Microscopically, however, there were some striking changes. The cortex and meninges were normal. In the subcortical areas, near the corpus callosum, was definite evidence of brain necrosis. Surrounding this necrotic area there were glial proliferation and many gitterzellen. Between the cells was a granular amorphous substance, particularly in the outer areas of this necrotic region. A great number of large reacting glial cells were scattered about. Between the cortex and this

TABLE IV—EXPERIMENTAL PRODUCTION OF DEPRESSSED BRAIN WITHOUT FRACTURE

Animal No	Weight kilos	Sacrificed at	Size of bead inserted mm	Pathological changes	
				Gross	Microscopic
15 b	3.6	2 days	2	Area of depression well defined	No evidence of pathological change
19 b	3.5	8 days	2	Area of depression well defined	No evidence of pathological change
25 b	3.4	18 days	3 1/4	Area of depression well defined	No evidence of pathological change
10-b	3.2	19 days	2	Area of depression well defined	No evidence of pathological change
5 b	3.2	20 days	5	Area of depression well defined	No evidence of pathological change
11 b	3.1	21 days	2	Area of depression well defined	No evidence of pathological change
1 b	3.2	30 days	5	Area of depression well defined	No evidence of pathological change
25 b	3.2	1 month	2	Area of depression well defined	No evidence of pathological change
13 b	3.7	3 months	2	Area of depression well defined	No evidence of pathological change
7 b	3.4	3 1/4 months	5	Area of depression well defined	No evidence of pathological change
20-b	2.8	14 weeks	2	Area of depression well defined	No evidence of pathological change
22 b	3.2	5 months	2	Area of depression well defined	No evidence of pathological change
24 b	2.6	5 1/4 months	2	Area of depression well defined	No evidence of pathological change
9 b	4.2	6 months	2	Area of depression well defined	No evidence of pathological change
2 b	3.2	9 months	2	Area of depression well defined	No evidence of pathological change
21 b	3.8	10 months	2	Area of depression well defined	No evidence of pathological change

TABLE V—OPERATIVE REMOVAL OF BEADS

Animal No	Weight, kilos	Period bead removed	Postoperative sacrifice months	Animal No	Weight, kilos	Period bead removed	Postoperative sacrifice months
16 b	3.1	1 day	5	6-b	3.2	11 weeks	6
18 b	3.0	4 days	5	14 b	3.4	13 weeks	6
22 b	3.7	7 days	5	21 b	3.2	14 weeks	5
4 b	3.2	20 days	5	25 b	3.0	5 months	4
26 b	2.4	2 months	4				

necrotic area there was a slight increase of glial cells and some of the nerve cells showed chromatolysis. In the rabbits sacrificed at a later period, it appeared as if this necrotic area more nearly approached the cortex. It is very important to note that the gross appearance of the cortex or meninges in no way foretold the conditions existing in the subcortical areas (Figs. 9, 10).

**Type D.** In the course of our experimental work, it so happened that, in 12 rabbits, fractures of such severity were produced as to lacerate the brain and dura. These were not utilized for this problem, but we mention them in passing. In Figure 6 will be noted a well rounded depression of the outer table, with spiculation of the inner table. From the general appearance of this outer table, it would be impossible to ascertain the existence of this spiculation. Upon the brain was noted

a well marked area of necrosis in addition to the area of depression.

#### EXPERIMENTAL PRODUCTION OF DEPRESSSED FRACTURES

**By pressure.** This group consisted of 6 rabbits in which depressions of the brain were caused by pressure applied to the plunger which then slowly crushed the thin bone of the rabbit's skull. In this manner, a depressed fracture was produced without striking a blow. Table III presents a protocol of the 6 rabbits of this series.

Upon study of Table III, it will be noted that these animals were sacrificed at a period of 24 hours to 12 months. In all of these animals there was a definite depression in the bone and the underlying brain without evidence of dural or brain laceration. The microscopic examination was entirely negative.

as to acute, traumatic pathological change and the late deep changes observed in Types B and C were absent also. From this observation, it is evident that localized pressure against the brain and meninges from depressed bone did not cause discernible morphological changes.

In this experimental work, when a simple depressed fracture was produced, the depression of the inner table tended to be less marked than that of the outer table. However, it was found that spiculation and cracking of the inner table may readily exist without evidence of such a condition of the outer table (Fig. 12).

#### EXPERIMENTAL PRODUCTION OF DEPRESSED BRAIN WITHOUT FRACTURE

The foregoing experiments have shown that depressed fractures caused by striking a blow produced both early and late pathological changes. Depressed fractures produced by pressure did not produce such changes.

In addition it was decided to produce varying depressions in the brain by the surgical introduction of small glass beads between the dura and the skull.

Under ether anaesthesia and with aseptic precautions, a small hole was trephined in the rabbit's skull. Glass beads were inserted through this opening and moved forward extradurally so as to remain *in situ*. Three sizes of beads were utilized, namely 2 millimeters, 3.5 millimeters, and 5 millimeters (Fig. 10). Each of these beads produced a greater depression upon the surface of the brain than our deepest "C" fracture. Table IV represents a protocol of the 16 rabbits comprising this series.

In the study of Table IV it will be noted that these rabbits were sacrificed at from 2 days to 10 months. After the placing of the beads, there was a deep depression upon the surface of the brain. Gross examination did not reveal any pathological changes. Microscopic examination revealed no changes other than some condensation of the brain tissue beneath the corresponding pit. There was no difference in the microscopic examination of the animal sacrificed at 2 days and that of the animals killed later.

**Operative removal of beads.** It was originally thought that possibly depressions caused by beads might produce pathological change and for this reason, a control series of 9 operative animals was used. Table V represents a protocol of the rabbits placed in this series. Upon study of this table, it will be noted that these animals were sacrificed from 4 to 6 months after the removal of the beads. These beads were removed at varying intervals of 1 day to 5 months. The brains, upon examination, showed the absence of pitting which the beads had created previously. Microscopic examination gave no evidence of condensation of the brain tissue in the position where the bead had been embedded.

#### CONCLUSIONS

Studies of the effects of simple, non-penetrating depressed fractures of the skull in rabbits have shown that

1 The changes in the brain are caused by the force producing the injury rather than the depression of the bone.

2 The pathological changes in the brain appear more marked in the early and in the late stages than during the intermediate period and are chiefly subcortical.

3 Depressions of moderate size cause no pathological changes in the underlying meninges and brain.

4 Following the production of depressed areas by slow localized compression or by the introduction of extradural foreign bodies, pachymeningitis, leptomenigitis, adhesions, softening, or cysts were not produced.

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## AN ANATOMICAL STUDY OF SUBDURAL HÆMORRHAGE ASSOCIATED WITH TENTORIAL SPLITTING IN THE NEWBORN

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**I**NTRACRANIAL hæmorrhage, associated with a tearing (or more correctly a splitting) of the tentorium cerebelli, in the newborn has anatomically acquired an increasing importance in recent years, while clinically and surgically it has received as yet very little consideration. It is the purpose of this communication to contribute an etiological and anatomical analysis of a series of 32 cases of subdural hæmorrhage associated with tentorial splitting, first, as regards the lesions, and second, as regards their clinical significance.

## ANATOMICAL INTRODUCTION

In order to appreciate the possible source of the subdural hæmorrhage and the formation of pathological lesions in the tentorium cerebelli, it is desirable to have a clear mental picture of the normal anatomy of the dura mater septa and its veins and sinuses.

The dura mater consists of two distinct layers. An outer, which is very vascular and serves as the bony periosteum, and an inner, which is but slightly vascular and may be considered the dura proper. It is the inner layer only which is prolonged inward to form the falx cerebri, the falx and tentorium cerebelli. These septa take origin along the venous sinuses which are themselves formed by clefts in the inner layer of the dura. They have a point of common union at the confluens sinuum (torcular herophili). As the name indicates it is the meeting-place of the superior sagittal, straight, occipital, and two transverse sinuses. It is excellently protected posteriorly by the thick internal occipital protuberance and on all other aspects by thick radiating fibers that form the dural septa.

On examining these septa one is at once impressed by the fact that they are not of equal thickness, but in definite places condense to thickened bands. Holland is convinced that these "strengthening bands" have

a definite protective function which is of highest importance during the stress of labor. The tentorium cerebelli contains more of these strengthening bands than any other reflection of the dura mater, and it is subjected to extreme strain during the stress of labor. There are (1) a curved band running obliquely downward and forward forming the anterior free boundary of the tentorium cerebelli, which is formed by the splitting of the fibers of the falx cerebri and is attached to the anterior clinoid process on either side, (2) a straight band running downward and backward at the junction of the tentorium cerebelli and the falx cerebri, a thickening which forms the floor of the straight sinus, (3) a curved band running slightly outward from the anterior boundary of the confluens sinuum and then horizontally forward to join the anterior free margin near its attachment to the anterior clinoid process (Fig. 5). These fibers are necessarily deep to the oblique fibers and do not form a boundary to the tentorium cerebelli. These three bands outline a triangular space which is, in the great majority of cases, the site of tentorial splitting (Fig. 4). From the point of origin of the anterior free margin superficial fibers radiate out like a fan to their insertion along the superior margin of the petrous temporal side and extend back to form the anterior wall of the confluens sinuum. Similarly, from the point of origin of the horizontal band, deep fibers radiate out less abundantly from the confluens sinuum. They cross the superficial fibers and finally join them at the free margin near the anterior clinoid process. The tentorium cerebelli is thus formed by two radiating systems of fibers: (1) a superficial, extensive, and predominantly vertical system, referred to as the superficial tentorial blade, and (2) a deep, rather sparse, and predominately horizontal system, referred to as the deep blade of the tentorium cerebelli.



## METHOD

The method employed for the examination of the intracranial contents in this series of cases is based on that originally described by Beneke (2) in 1910. We employed the slight modification which appeared in a later paper by Beneke and Zausch (3). This method permitted a more careful examination of the great cerebral vein and its tributaries. The cerebral hemispheres were ablated, care being used to preserve the posterior part of the third ventricle and the corpora quadrigemina. The falx cerebri and longitudinal sinus were preserved in every instance by making incisions 1.5 centimeters parallel to either side of the sagittal suture line. These incisions were carried forward through the frontal bone to meet the anterior extremity of the lateral incisions just above the orbital plates. The infratentorial basilar structures were examined by removing triangular windows from the occipital bone just below the lateral sinuses on either side of the midline.

This technique has the advantage of permitting a good exposure of the supratentorial fossae and of all the reflected dural septa, with a minimum of manipulation. It therefore, permits a careful examination of the most common sites of subdural and leptomeningeal hemorrhage, as well as of the dural septa, and it greatly reduces the liability of postmortem tears (artifacts). The marked increase in the percentage of intracranial lesions in the newborn which have been recorded in recent years is probably more apparent than real. It is due partly to the general adoption of this technique.

The anatomical evidence for prematurity must be carefully considered because this represents by far the most important predisposing factor to both intracranial hemorrhage and tentorial splits. Absolute evidence of prematurity is very difficult to establish. There can be no absolute certainty that the age of the individual fetus has been correctly estimated. None of the three methods usually employed is entirely satisfactory. In order of their importance Cruickshank and Miller enumerate these methods as follows: (1) measurement of body length and weight, (2) measurement and enumeration of centers of

ossification, (3) the menstrual history of the mother. The measurement of body length and body weight is obviously limited in value by differences in the state of nutrition in fetuses of the same age. This is readily shown by Browne's length weight ratio (obtained by dividing the weight by the length). Hess has tabulated and compared records of fetal lengths and weights which further demonstrate the unreliability of records of fetal weights as compared with records of fetal lengths as an indication of prematurity. He finds the average fetal length at the end of the tenth lunar month to be 48.4 centimeters. We have, therefore, accepted a length of 48.0 centimeters and over as the most reliable anatomical evidence of maturity in the present study. We have compared this anatomical evidence with the clinical evidence as indicated by the menstrual history of the mother. In our series of 32 cases of tentorial splitting, we find that 13 infants were premature as indicated by the mother's history, and that the same number were premature as indicated by the length of less than 48.0 centimeters. In 2 cases, however (7 and 10), the clinically premature infants measured 48.0 centimeters or more, and in 2 other cases (28 and 31) the clinically full term infants measured slightly less than 48.0 centimeters. We have, therefore, a similar small margin of error, whether we accept the clinical or the anatomical evidence for prematurity.

## PATHOLOGICAL FINDINGS

**Subdural hemorrhage.** In this series of cases it is of significance to note that the intracranial hemorrhage was almost completely confined to the subdural space. A classification of subdural hemorrhage is unavoidably an arbitrary one because of the difficulty of accurately judging the diffuseness and quantity of the blood. The hemorrhages were grouped as small, moderate, and large. This purely arbitrary standard was established after a comparative study of all the cases.

In regard to the amount and position of subdural hemorrhage four significant points relative to its source were noted: (1) Slight or moderate amounts of blood were usually confined to the posterior (occipital) and middle

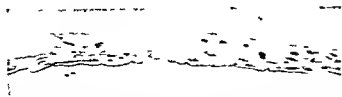


Fig 1 Transverse section through the tentorium cerebelli showing evidence of stretching. Note the separation of the superficial vertical fibers and thinness of the deep horizontal fibers  $\times 34$

(temporal) fossæ while large amounts of blood usually include also the anterior fossa. (2) In nearly every instance blood was found in the subdural space either surrounding the great cerebral vein or its tributaries close to its junction with the straight sinus. In no instance, however, were we able to demonstrate an actual rupture of the great cerebral vein. (3) In every instance but one the subdural hemorrhage was very largely confined to the supratentorial fossæ. In this instance (Case 29) there was, in addition to the supratentorial hemorrhage, extensive clot surrounding the base of the brain. This was a case of podalic version with extraction in which there was evidence of stretching of the ligaments between the base of the skull and the atlas and axis. The anatomical picture indicated that torn meningeal basilar vessels were the source of the subdural hemorrhage in this instance. (4) There was no definite relation between the degree of tentorial damage and the amount of subdural hemorrhage (See analysis of cases.)

In the light of these observations what is the usual source of the subdural hemorrhage in the newborn? There are three sources to be considered in relation to tentorial lesions: (1) small intratentorial vessels, (2) emissary veins, (3) tributaries of the great cerebral vein.

In an attempt to determine the venous supply of the tentorium cerebelli and other dural septa, an injection of the great sinuses and their tributaries was made in a series of 10 cases. The injecting fluid used was India ink in a suspension of 15 per cent glycerine. After being washed for 20 minutes with normal saline, the longitudinal sinuses were injected through the anterior fontanelle. The fluid was allowed to escape through incisions in the

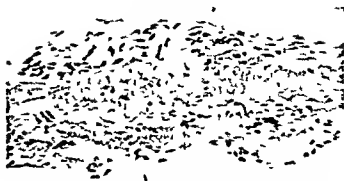


Fig 2 Tentorium cerebelli in an 8 months premature stillborn infant. Note the uniformly immature fibrous connective tissue cells and the extravasated red blood cells between the tentorial layers  $\times 110$

jugular veins. These preparations were then hardened in 6 per cent formalin after which the dural septa were exposed in the usual way. The following observations are the result of a careful gross examination of these specimens.

1 There is, in many cases a small intratentorial vein running more or less parallel to and just below the deep horizontal band. It appears to join the posterior end of the straight sinus (Fig 5).

2 Relative avascularity of the tentorium in the full term infant as compared to the definitely premature fetus.

3 Complete absence of emissary veins in the triangular space.

4 Several tributaries joining the great cerebral vein as it approaches the anterior end of the straight sinus.



Fig 3 Tentorium cerebelli in a full term stillborn infant. Note the maturity of the fibrous connective tissue cells as compared with the picture in Figure 2  $\times 100$

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This technique has the advantage of permitting a good exposure of the supratentorial fossa and of all the reflected dural septa, with a minimum of manipulation. It therefore permits a careful examination of the most common sites of subdural and leptomeningeal hemorrhage as well as of the dural septa and it greatly reduces the liability of postmortem tears (artifacts). The marked increase in the percentage of intracranial lesions in the newborn which have been recorded in recent years is probably more apparent than real. It is due partly to the general adoption of this technique.

The anatomical evidence for prematurity must be carefully considered because this represents by far the most important predisposing factor to both intracranial hemorrhage and tentorial splits. Absolute evidence of prematurity is very difficult to establish. There can be no absolute certainty that the age of the individual fetus has been correctly estimated. None of the three methods usually employed is entirely satisfactory. In order of their importance Cruickshank and Miller enumerate these methods as follows: (1) measurement of body length and weight, (2) measurement and enumeration of centers of

ossification, (3) the menstrual history of the mother. The measurement of body length and body weight is obviously limited in value by differences in the state of nutrition in fetuses of the same age. This is readily shown by Browne's length weight ratio (obtained by dividing the weight by the length). Hess has tabulated and compared records of fetal lengths and weights which further demonstrate the unreliability of records of fetal weights as compared with records of fetal lengths as an indication of prematurity. He had the average fetal length at the end of the tenth lunar month to be 48.4 centimeters. We have, therefore, accepted a length of 48.0 centimeters and over as the most reliable anatomical evidence of maturity in the present study. We have compared this anatomical evidence with the clinical evidence as indicated by the menstrual history of the mother. In our series of 32 cases of tentorial splitting we find that 13 infants were premature as indicated by the mother's history, and that the same number were premature as indicated by the length of less than 48.0 centimeters. In 2 cases, however (7 and 20), the clinically premature infants measured 48.0 centimeters or more, and in 2 other cases (18 and 31) the clinically full term infants measured slightly less than 48.0 centimeters. We have, therefore, a similar small margin of error, whether we accept the clinical or the anatomical evidence for prematurity.

## PATHOLOGICAL FINDINGS

**Subdural hemorrhage.** In this series of cases it is of significance to note that the intracranial hemorrhage was almost completely confined to the subdural space. A classification of subdural hemorrhage is unavoidably an arbitrary one because of the difficulties of accurately judging the diffuseness and quantity of the blood. The hemorrhages were grouped as small, moderate, and large. The purely arbitrary standard was established after a comparative study of all the cases.

In regard to the amount and position of subdural hemorrhage four significant points relative to its source were noted. (1) Slight or moderate amounts of blood were usually confined to the posterior (occipital) and middle



Fig 6 Case 5. Premature fetus showing extensive superficial split of the stretched vertical fibers of the tentorium cerebelli. There is also an oval split in the anterior part of the falx cerebri. Note the diffuse intradural hæmorrhage. (Also illustrates method of opening skull.)



Fig 7 Case 8. Complete split of the tentorium cerebelli with surrounding intradural hæmorrhage. The opposite side of this specimen is shown in Figure 8.

superficial fibers more prominent than usual, and an arrangement of these fibers into linear ridges. The separation of these superficial fibers is well demonstrated in the histological sections (Fig 1). In the more extreme cases in which there is a complete split of both tentorial blades a marked degree of stretching and separation of the fibers is readily demonstrable well beyond the ragged margin of the split (Figs 7 and 8). A similar picture of tentorial splitting may be produced artificially by exerting vertical traction on the vertex of the skull after the modified Beneke's exposure of the dural septa is made. The superficial vertical fibers therefore stretch separate into bands and finally split apart transversely (rather than tear) while the deep transverse fibers separate and finally split apart longitudinally.

Tentorial splits may be either unilateral or bilateral. The lesions are superficial, complete, or perforating in character. In the superficial type there is an irregular transverse splitting of only the upper vertical blade of the tentorium. Thus the intact deep horizontal blade is exposed covering the cerebellum (Fig 6). In the complete type both superficial vertical and deep horizontal blades are split (Figs 7 and 8). When the anterior free margin remains intact the split is re-

ferred to as perforating in character (Fig 9).

The frequency of tentorial splitting in premature infants after an easy spontaneous delivery is well recognized. There have been many explanations offered as to why the fibers of the tentorium cerebelli should be



Fig 8 Case 8 A split of the anterior free margin of the tentorium with extensive stretching and separation of the fibers and intratentorial hemorrhage

premature fetus. This opinion is based on a careful comparative study of histological sections taken from similar areas in the triangular tentorial space from the premature and full term infant. The sections from the premature infant show 3 important differential points (Figs 2 and 3) (1) a predominance of fibroblasts with few collagen fibrils, (2) absence of elastic tissue fibrils (Wigert's stain), (3) relative abundance of lymph spaces and thin walled blood vessels. The immaturity of the fibrous connective tissue with its absence of collagen and elastic fibrils are all indicative of its increased friability.

The relative unimportance of tentorial splitting *per se* is well demonstrated by the specimen shown in Figure 10. This 5 month old infant never had symptoms referable to an intracranial lesion. He died of septicæmia following an exudative purulent mastoiditis and otitis media. There is gross evidence of scar tissue formation in the superficial tentorial blade and a vertical split close to the anterior free margin still remains open. A little yellowish brown pigment covered the dura mater over the posterior supratentorial fossa. This pigment gave the prussian blue reaction. It represented an old subdural hæmorrhage. Ford calls attention to the fact that as far back as 1890 Kundrat described old blood pigment in the meninges of children up to 9 months of age who gave no evidence

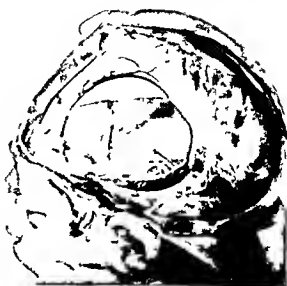


Fig 9 Complete split of tentorium through the anterior free margin and a perforating split in the posterior fossa

of birth injury at the time of birth. The association of a partly healed tentorial lesion has been more recently described by Schule. Such cases are conclusive evidence that extensive tentorial splitting with subdural hæmorrhage heal spontaneously without symptoms.

*Perforating split of the falx cerebri.* This lesion was found in four instances (Cases 5, 7, 17, and 32). It will be noted (Fig 6) that the long axis of the oval perforation is in the direction of the radiating fibers of the falx. The absence of intradural hæmorrhage and extravasated blood between the cerebral hemispheres indicates the avascularity of the anterior half of this dural septum. This was further demonstrated in the India ink injections. On account of the avascularity of the portion of the dura usually involved, these perforations in themselves are of no clinical importance. They are chiefly of interest because they are associated with extensive bilateral tentorial splitting. This was complete in three instances and superficial in the premature fetus shown in the photograph.

#### ETIOLOGY

Subdural hæmorrhage with splitting of the fibers of the tentorium cerebelli are indisputable evidence of intracranial trauma. The

causes of intracranial trauma are conveniently divided into predisposing and determining factors. By far the most important predisposing factor to intracranial hæmorrhage as well as to tentorial splitting is prematurity. The anatomical explanation for both these lesions in the premature fetus has already been indicated. The 13 fetuses in this series of 32 cases represent a frequency of 40 per cent.

Syphilis is apparently important only as a predisposing cause of tentorial splitting in so far as it tends to favor premature birth of the fetus (Brissaud).

The mechanical determining factors are by far the most important of the determining causes of these intracranial lesions. Practically without exception lesions of the dura mater are partly due to mechanical causes. Beneke (2) described 14 cases of tentorial tears in 100 autopsies on stillborn babies. Two years later Seitz reported tentorial lacerations in half of his cases. More recently Capon investigated 80 neonatal and stillborn infants. He found intracranial hæmorrhage in 37.5 per cent and dural lacerations in 47.5 per cent. In a series of 145 autopsies on babies under 4 weeks old, we have found intracranial hæmorrhage in 50 cases. This represents a frequency of 37 per cent. In 32 of these 50 cases, the hæmorrhage was very largely subdural and there was also a splitting of the fibers of the tentorium cerebelli. This represents 64 per cent. In other words, about two-thirds of our cases of subdural hæmorrhage showed a split tentorium. Many of these were superficial and small, however, and would have been overlooked in a less careful routine examination.

It is not within the scope of this paper to discuss the forces of stress and strain on the fetal head during its passage through the birth canal. It is well recognized that excessive head molding, which accounts for a large number of these lesions, is based on a disproportion in size between the maternal bony pelvis and the fetal head. Beneke's (2) original work on this subject has more recently been elaborated by Holland, Ehrenfest, Warwick, and others. Holland has shown quite convincingly that pressure of the fetal head in one diameter results in a shortening in that diameter and a compensatory increase



Fig. 10. A partly healed tentorial split. Note the persisting small oval perforation just behind the anterior free margin.

in some other diameter. Greenwood agrees that the vertical diameter of the head is always increased in breech presentation, but he shows by careful measurements with plaster casts that the suboccipital bregmatic diameter, which is engaged in normal labor, does not produce vertical elongation of the head but causes an actual decrease in this diameter with an increase in the horizontal component. This seems a most logical explanation for the much larger proportion of tentorial splitting in brow and breech presentations over vertex presentations. Ford points out the interesting observation made by Schwartz that animals with solid skulls do not suffer birth injuries.

There can be no doubt that the mechanical process of head-molding during labor, which is so often responsible for intracranial trauma, is in many instances further aggravated by the operative manipulations of even the most careful obstetrician. In this series of 32 cases exactly half of them have a history of operative interference. This figure indicates that every case of prolonged and difficult labor must be treated as a potential case of subdural hæmorrhage with split tentorium cerebelli. Any operative interference, however slight, must be done with extreme care, on the general assumption that intracranial trauma has already occurred.

Case No	Intra uterine age	Neo natal age	Para	Duration of labor in hours	Position at labor	Course of labor and in the case of operative interference	Length in cm	Weight in grams	Tentorial split				Subdural hemorrhage				Other gross lesions	
									Right		Left		Posterior		Degree			
									Extent	Length in cm	Extent	Length in cm	Right	Left	Right	Left		
1	Term	Dead born	I	10	L.O.A.	Low forceps with gentle traction Eclampsia	48	1650			Superficial	25			Posterior fossa	Small		
2	Term	9 hr	I	10	L.O.A.	Spontaneous delivery	52	1250			Superficial	08			Posterior and middle fossae	Small		
3	Term	6 da	VII	2	L.O.A.	Four loops of cord about neck Difficult spontaneous delivery	50	1470	Complete	20					Posterior and middle fossae	Large		
4	Term	9 da	V	ca 13	L.O.A.	Infinitesimal onset of labor Slow spontaneous delivery	50	1450	Superficial perfracture	05								
5	5 1/2 M	10 min	III	ca 16	L.O.A.	Spontaneous delivery	47	1930	Superficial	12			Superficial	25	Posterior and middle fossae	Small		Split in anterior third falx cerebri 5 by 2 cm
6	6 M	Dead born	I	8	R.S.A.	Bag induction Eclampsia	50	1890	Superficial	10			Complete	16	Posterior and middle fossae	Moderate		
7	8 M	10 min	II	ca 14	R.S.A.	Easy spontaneous delivery	45	2210	Complete	08			Complete	08	All fossae	Large		Split in middle third falx cerebri 5 by 1.5 cm
8	Term	48 hr	III	10	R.O.P.	Cervix not fully dilated. Forceps version with extraction Prolapsed cord	50	3200	Complete	05			Complete	15	Posterior and middle fossae	Moderate		
9	Term	13 da	II	ca 48	L.O.P.	M. Injuncta. Transverse at rest of head	51	2820			Superficial	12			Posterior and middle fossae	Moderate		Intracranial hemorrhage by lateral
10	8 M	10 hr	II		L.O.A.	Spontaneous delivery	50	2100			Superficial	10						
11	8 M	6 da	I	6	L.O.A.	First twin Difficult slow forceps. Flat pelvis	45	1550			Superficial	11			Posterior fossae	Small		
12	Term	Still born	VIII	ca 20	R.O.A.	Slow spontaneous delivery	50	3000	Complete	03			Complete	18	Posterior and middle fossae	Large		
13	7 M	10 hr	VI	21	R.O.A.	Podalic version and extraction. Transverse forceps in 1st lapar arm	45	2050	Complete	10			Complete	14	All fossae	Large		
14	6 1/2 M	Still born				Spontaneous delivery	37	1510	Superficial complete	06			Complete perfracture	10	Posterior and middle fossae	Moderate		
15	Term	4 da	III	0	L.O.A.	Low forceps Rapid perfracture	50	2660			Superficial	16			Posterior fossae	Small		
16	Term	Still born	I	ca 25	R.O.A.	Slow spontaneous delivery	50	3550	Complete	12			Complete	08	Posterior fossae	Moderate		

17	7:55M	1 hr	I	20 min	LOA	Bag induction Midforceps Clamp	42	2 160			Complete perforating	15	All fossæ	All fossæ	Large	Large	Perforation into torcular herophili left side in middle third falx cerebri 4 by 2.5 cm
18	Term	4 da	I	20	LOA	Low forceps Rigid perineum Eclampsia	50	3 160	Complete	07	Superficial	18	All fossæ	Post and mid die fossæ	Large	Small	
19	7:55M	4 hr	IV	6		Placenta previa marginalis Contracted pelvis 1 1/2 inches due to scar tissue Cesarean section	46	2 260	Superficial	08	Superficial	12					Intracranial hæmorrhage by lateral
20	7:55M	Dead born	I	10	ROA	Spontaneous delivery	46	1 480	Superficial	25			Post and mid die fossæ		Small		
21	Term	Still born	II	15	ROA	Spontaneous delivery	48	1 580			Complete	21		Post and mid die fossæ	Small		
22	7 M	18 hr	V	5	ROA	Second twin Spontaneous delivery	43	1 640	Complete	20			All fossæ	Middle fossæ	Large		Fetal hydrops
23	8 M	Still born	III	8	ROA	Placenta previa marginalis Bag induction Midforceps	46	2 750	Complete	15	Complete	15	Middle fossæ	Middle fossæ	Small	Small	
24	Term	Dead born	II	11 1/4	LOP	Contracted pelvis High forceps Trauma of labor	50	3 850	Complete	28	Complete	30	All fossæ	All fossæ	Large	Large	
25	Term	Still born	I	8	LOA	High forceps Persistent oblique Rigid perineum	52	4 300	Complete	14	Complete	16	All fossæ	All fossæ	Large	Large	Infarction adrenal bilateral
26	Term	3 da	VI	14 1/4	ROA	Spontaneous delivery	50	3 060	Complete	10	Complete	12	All fossæ	All fossæ	Large		(Postmortem lesion)
27	ca 7 M	Dead born	II	8	LOA	Spontaneous delivery	44	1 800	Complete	22	Complete	22					
28	Term	3 da	I	ca 14	LSA	Difficult delivery of large head Manipulation	42	2 840	Superficial	26	Superficial	05	Post and mid die fossæ	Post and mid die fossæ	Small	Small	Infarction right adrenal
29	Term	7 hr	III	7	ROA	Podalic version and extraction Contracted pelvis Floating head	50	3 170	Superficial	15	Complete	15	All fossæ	All fossæ	Large	Large	Large subdural basilar hæmorrhage
30	Term	6 hr	III	6	LOA	High forceps Persistent right transverse	52	3 420	Complete	18	Complete	28	Post and mid die fossæ	Post and mid die fossæ	Modest	Modest	
31	Term	2 da	I	ca 40	RSA	Difficult spontaneous delivery Just anterior pelvis	46	2 400	Superficial	12	Superficial	10	Post fossæ	Post and mid die fossæ	Small	Small	Congenital anomalous of heart Tetralogy of Fallot
32	Term	30 hr	V	16	ROP	Podalic version and extraction Flat pelvis Floating head	50	4 000	Complete	24	Complete	20	Post and mid die fossæ	Post and mid die fossæ	Modest	Small	Split in middle third falx cerebri 5 by 3.5 cm



The application of forceps is by far the most common operative manipulation associated with these intracranial lesions. It represents 31 per cent of our series of cases.

Podalic version and breech extraction is next in order of frequency. Combined with four primary spontaneous breech deliveries this group represents a total of 8 cases, or a frequency of 25 per cent. The mechanical explanation for the well recognized frequency of tentorial splitting in breech presentations was first advanced by Wilke and Seitz in 1912. More recently Greenwood has shown that the vertical lengthening of the head is usually due to the occiput being firmly pressed against the symphysis pubis. Crothers has demonstrated that the vertical lengthening of the supratentorial chamber in these cases causes a marked strain and stretching of the tentorium. This strain is further increased by any traction on the body from below which he thinks is partly transmitted through the vertebral column and spinal cord.

The more unusual measures which may be associated with subdural hemorrhage and tentorial splitting include cesarean section operations and some methods of resuscitation. A cesarean section was the operative interference in Case 19. There were two indications: a contracted pelvis and a placenta prævia. This woman had a uterine dystocia which was probably due to three previous cesarean sections. The operation was done after slight engagement of the head in the left occiput anterior position for 6 hours. The baby was definitely premature. This case is of particular interest because it suggests two possible causes of subdural hemorrhage and tentorial splitting which would be even more liable to occur in prematurity: (1) early engagement of the head in a small pelvis, and (2) a forced extraction of the head through a uterine incision of insufficient length.

Since Bauereisen's experiments demonstrating that tentorial splits can be produced by the lateral compression of the head by holding it fixed during Schultze's method of resuscitation, this method has been generally discarded. It was not employed in any of this series of cases. Any method of resuscitation which necessitates compression of the head, or

swinging methods which cause engorgement of possibly ruptured intracranial vessels, is obviously contra indicated.

#### ANALYSIS OF CASES

*Clinical analysis.* The cases fall naturally into three groups depending on the type of labor and the necessity for operative interference.

	Cases
Group 1 Easy spontaneous deliveries	10
Group 2 Difficult spontaneous deliveries without operative interference	6
Group 3 Difficult labors with operative interference	16

Group 1 Prematurity was the common predisposing factor to the intracranial lesion.

Group 2 In these 6 cases (3, 4, 12, 16, 28, and 31) of slow and difficult but spontaneous full term deliveries, the mechanical process of molding of the fetal head in its passage through the birth canal for some reason was unduly prolonged. This group indicates that the factors which are responsible for prolonged and difficult labor in the full term infant are just as important causative factors to tentorial splitting and subdural hemorrhage as are the operative manipulations of the experienced obstetrician.

Group 3 The 16 cases of difficult labor with operative interference may be grouped according to type of operative procedure used.

	Cases
Forceps deliveries	10
Podalic version and breech extraction	4
Bag induction spontaneous breech	1
Cesarean section	1

The indications for operative interference were always very definite. They are noted in the table accompanying this article.

*Anatomical analysis.* The intracranial anatomical lesions are grouped as follows.

#### Summary of tentorial splits

	Cases
Unilateral superficial	8
Unilateral complete	4
Bilateral superficial	4
Bilateral complete	12

A summary of subdural hemorrhage in relation to tentorial splits is shown in the following table.

## SUBDURAL HÆMORRHAGE AND TENTORIAL SPLITS

Type of tentorial split	Degree of subdural hæmorrhage				
	Cases	Small	Moderate	Large	Absent
Unilateral superficial	8	5	1		2
Unilateral complete	4	1		3	
Bilateral superficial	4	3			1
Bilateral complete	12	1	4	6	1
Bilateral mixed	4		2	2	

There is obviously no absolute relation between the extent of the tentorial damage and the amount of subdural hæmorrhage. It is notable, however, that large hæmorrhages are found most frequently in cases in which there is a complete bilateral tentorial split.

## SYMPTOMS

Only a short reference to the antemortem symptoms will be included here. The typical textbook picture of intracranial trauma is seldom recorded in the histories of these babies. Shallow and labored respirations with usually a persistent moderate degree of cyanosis are by far the most constant clinical findings mentioned. In over 90 per cent of the neonatal infants in this series, these are the only recorded symptoms. The remaining cases showed, in addition to this picture of asphyxiation, the following signs of intracranial irritation in order of their frequency, bulging of the anterior fontanelle, convulsions, and spasmodic twitching of both extremities and face. All those cases which had these latter signs showed a large or moderate subdural hæmorrhage in the supratentorial fossæ on one or both sides.

It is hoped that this anatomical analysis of the cases here recorded may, in addition to its theoretical interest, suggest to neurological surgeons means and methods to lower the high mortality in this type of intracranial injury.

## SUMMARY

Based on observations from an analysis of 32 cases of subdural hæmorrhage with tentorial splitting, our conclusions are

1 Subdural hæmorrhage is the important intracranial lesion in most cases of birth trauma.

2 There is nothing to indicate that intradural hæmorrhage or tentorial splits *per se* are of noteworthy clinical significance.

3 The subdural hæmorrhage is largely supratentorial and often bilateral. It is usually due to a stretching and rupturing of the small tributaries of the great cerebral vein near its junction with the straight sinus.

4 Tentorial splits are relatively more numerous in the premature than in the full term infant, partly because of the greater immaturity of fibers of the dural septa in prematurity.

5 The causes of prolonged and difficult labor may be equally as important in these intracranial lesions as the operative interference.

6 Signs of asphyxiation were constant, but definite signs of intracranial irritation were recorded in only a small minority of cases.

I wish to express grateful thanks to Mr J. CIRoux, of the McGill University Museum Staff, for the valuable technical help which has made this investigation possible.

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## SENILITY OF BONE AND ITS RELATION TO BONE REPAIR

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**D**URING the preparation of material for a previous article on "The Organic Content of Bone," the variation in thickness and the gross appearance of the walls of the femur, tibia, and fibula were so marked as to be considered worthy of investigation. Sections of these bones were ground and studied and extensive changes were noted in some of them. The thought naturally arose that here might be the solution of the variation in the repair of bone in elderly individuals.

The practitioner is familiar with the fact that in those past the middle period of life, fracture of the femur or of the tibia may be a serious matter, as far as future locomotion of the patient is concerned. In some individuals sudden excessive muscle strain may be attended with near disastrous results. The physician is also acquainted with the fact that in the aged a mere stumbling or tripping, with the attendant sudden and violent muscle contraction, will cause the femur to snap. Why? Also, such a patient may have a prolonged or protracted recovery, or, not unlikely, may be bedridden for the remainder of his or her days, or, at best, hobble around with the aid of a cane or crutches. Why?

On the other hand, such individuals may have a complete and uneventful recovery in the usual time and show no untoward effects of the accident. Why? We are as old as our bones may be said of these structures as well as of the various organs of our bodies. There must be some physical or chemical basis for this difference and this should show microscopically. With this in mind, a careful study of many sections of ground bone was made to determine the presence of such a condition.

In order to understand the change that may occur in the bones of the aged, it will be necessary first to consider the structure of compact bone. One would naturally believe that compact bone would be the same, no matter where found and at any age. One would also be inclined to believe that compact bone would

be the same in all animals possessing a pronounced skeleton. However, these suppositions are far from the truth. In fact, there is a difference in the structure of the compact bone, say the femur, in the various classes of the human race (negro, yellow brown, and white). This type of bone shows evolutionary changes that are not as simple as they may seem. The lowest and earliest form is basic bone and this advances to the lamellar variety, then laminar form, and ultimately by the addition or formation of haversian systems, the highest type is reached. As in the case of civilization, the penalty of which, we may say, is disease, so in the evolution of bone in the development of a highly evolved type, in which the haversian systems predominate, there is likewise a penalty attached, that of the peculiar changes of senility. This seemingly affects only the highest type of bone, that of the Caucasian, in which the haversian systems have reached their greatest development.

In order better to follow the description of the various types of compact bone, a few of the terms used will be elucidated.

*Basic bone* is the earliest form of osseous tissue and consists of only moderately differentiated bony substance, as is seen in early fetal life. Lamella formation has as yet not occurred. Basic bone represents the first end product of the replacement of fibrous tissue or cartilage by osseous tissue.

A *lamella* is a thin layer of osseous tissue and represents a comparatively small structure of the whole.

A *lamina* is larger and more complex, it consists of a set of bone layers or lamellae. It comprises a variable number of concentric sheaths of lamellae just under the periosteum or bounding the medullary cavity, each lamina being separated from the adjacent one by systems of plexuses of vascular canals that extend parallel to the marrow cavity. Laminæ are seen in birds, mammals, in later fetal life, and in early childhood.

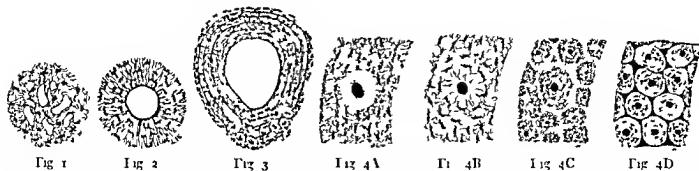


Fig 1 Basic or undifferentiated bone

Fig 2 Differentiated bone with concentric lamellae

Fig 3 Latest stage of differentiation of laminae

Fig 4 Various stages in the progressive development of

an haversian system. A, Early (amphibian), B, later (reptile), C, third stage, the systems are more distinct though still hazy (birds), D, completely differentiated systems (mammals and Man)

An *haversian system* consists of a central canal surrounded by three to eight concentric lamellae, between the latter are the lacunae and the canaliculi that usually have a straight course. The canaliculi connect the lacunae of a system to one another. In the early form of bone, the lamellae are not concentrically arranged, are more or less independent of the canals, and are variable in diameter. The lowest type of haversian systems is seen in the amphibians, where they are rather hazy and indistinct. In reptiles and birds they become more distinct, while in man they reach their climax of development.

#### TYPES OF BONE

While there are three main types of compact bone, these do not commonly exist individually or separately. The compact bones of the various animals are chiefly combinations of any two or of all three types.

*Type I* Basic bone represents the first type and this is the earliest form of osseous tissue. It is only moderately differentiated bony substance and is seen in early fetal life. The lamellae have as yet not been differentiated. This state may be followed by lamellar formation of the concentric type and the lamellae then become concentrically arranged. At first the lacunae are round, then oval, and lastly they become long and narrow. In many animals the changes stop here and so they belong to the first type. The bone lamellae are joined by cement, but the exact manner in which this and the lamellae are formed is unknown. Although many animals possess this simple type, it is not common. Sub-

types exist, but they will not be considered here.

*Type II* In this form, the lamellae have become somewhat differentiated and haversian systems may even be present, but the ordinary lamellae predominate. If the differentiation is not extensive, it is spoken of as incomplete, as in some birds. Here the basic bone is separated, partially, into distinct lamina by a few short vascular canals that have a general concentric position.

In the complete variety, the vascular canals form a more or less complete circuit, the laminae are well defined, the lamellae are completely developed, and the lacunae are long and narrow. This represents lamellar and laminar bone.

*Type III* In this variety the haversian systems are very numerous and reach their highest development. They represent the unit of structure. The internal and external lamellae are merely thin bands of bone. The stage of differentiation may be complete or incomplete.

In the incomplete form, there may be only a slight suggestion of haversian canals and systems, the canals are minute, irregular, and directed parallel to the long axis of the bone. The canal is surrounded by a clear zone of bony substance, usually circular in outline, the canaliculi that extend to the neighboring lacunae may readily be noted. The lamellae are not concentrically arranged and are more or less independent of the canal. This structure is seen in amphibians and up to Man.

A somewhat more advanced stage shows the haversian systems fairly well outlined,

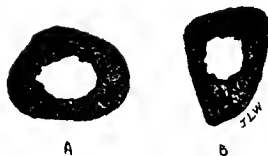


Fig 5 Medullary index A Femur showing a medullary index of 31.7 per cent (a little below average) B, Tibia of same extremity showing a medullary index of 20 per cent (probably quite low) Bone normal

and a more definite relationship between the lacunæ and the haversian system and canal is noted. This is first found in the reptilian class but is not seen in birds.

In another step of differentiation, the canaliculi are intricate, the haversian lamellæ are regularly and definitely arranged, concentric to the canals, and the canaliculi form a dense plexus. The complete system in its earliest form has a somewhat dull and hazy appearance and is found only in birds.

In the completely differentiated variety, the haversian systems are clear and distinct and this type is found in higher mammals and Man. It does not occur in the lower mammals, such as the monotremes, marsupials, edentates, and chiropters. Haversian systems, therefore, are found in nearly all types of bone, but in varying degrees of development, from the mere outline of the amphibians to the sharp, clear and definite type in Man.

Types I and II of compact bone are chiefly combinations of lamellæ and haversian systems. Types I, II, and III are combinations of haversian systems, lamellæ, and lamina.

#### MEDULLARY INDEX

An anatomical factor bearing upon the strength of compact bone and its repair, is the *medullary index*. An increase in the index will mitigate against a satisfactory resistance to bone strain and also against its successful repair in the event of fracture. This is due to the fact that the usual causative factor of increase is senile change of bone. This itself reduces the quality and strength of the bone,

thereby greatly influencing the reparative process unfavorably.

The medullary index represents the relation between the diameter of the bone and the diameter of the medullary cavity. It really indicates the thickness of the bony shell or wall. It has been worked out in the femur, but not in the other long bones, except the tibia in the present work. The thicker the bony wall, the stronger the bone will be, the marrow cavity will be smaller and, therefore, the medullary index lower. As the bony wall becomes thinner and the marrow cavity larger, the index increases. This naturally has its effect upon the resistance of the bone as well as upon its repair.

The medullary index is lowest in reptiles (in turtles there is practically no marrow cavity) and is given as 26.1 per cent. In birds, the index is highest with an average of 159.0 per cent. The average index in the human is 38.6 per cent, varying from 35.9 per cent in the Caucasian to 41.9 per cent in the negro. In the yellow brown race the index is 39 per cent.

#### BONE REPAIR AND REGENERATION

When a bone is fractured and it heals with the formation of normal bone, this process constitutes bone repair. It is in reality, bone regeneration. Only a few of our tissues have the power of regeneration, but fortunately we are capable of regenerating osseous tissue. In those individuals in whom bone regeneration is low or wanting, the union of the fractured parts is by means of fibrous tissue or cartilage. With the attendant loss of the original rigidity, the use of the limb is greatly affected or lost.

Bone readily regenerates, provided the periosteum is present. If a bone be broken, a blood clot forms in the marrow cavity beneath the periosteum and between the ends of the fragments. The periosteum is rarely torn completely through, as there is usually a bridge of membrane between the ends of the fragments of the bone.

The clot becomes organized through the proliferation of the various cells, especially those of the endothelial type, and fibroblasts are formed. This fibrous mass is invaded by



Fig 6 Medullary index A, Femur showing medullary index of 26.7 per cent (rather low) The bony wall is quite thick B, Corresponding tibia showing a medullary index of 44.2 per cent (probably about average) Bone normal



Fig 7 Medullary index A, Femur showing a medullary index of 62 per cent (very high) B, Corresponding tibia showing a medullary index of 72 per cent (very high) Both bones showed evidence of extensive senile changes

osteoblasts from the marrow and the deeper parts of the periosteum and these cells proliferate. This fibroblastic mass then becomes vascularized and constitutes *granulation tissue*. Following this, bone may be directly formed or a moderate amount of cartilage may first be produced. This represents *callus* and that portion in relation with the periosteum is likely to show some cartilage formation, but the remainder usually becomes directly ossified. An absence of the osteoblasts leave the mass fibrous or cartilaginous. This may be a permanent state and is presumably the result of weakened activity upon the part of the osteoblasts. When the fibrous mass holding the fragments of bone together, becomes ossified, then the bony union is completed. This is all a replacement process and not a change of one kind of tissue into another.

One might state that during the first week after the fracture, there is the formation of the clot and the organization thereof, during the second week this becomes greatly strengthened by dense fibrous tissue in and beneath the periosteum. During the third week ossification begins at points farthest from the ends of the fragments, usually by the end of the sixth week ossification between the ends of the fragments is completed. This intervening new bone is a solid, spindle-shaped mass that fills the marrow cavity as well as projects beyond the general surface of the bone.

The name *callus* is successively applied to the fibroblastic tissue, the granulation tissue, the fibrous tissue, and the resultant bone. That portion in the marrow cavity is the central callus, that surrounding the bone be-

yond the general level of the bony surface is the ensheathing callus. These two types constitute the temporary callus. The central callus may later be removed, thus restoring the marrow cavity, while the osteoclasts tend to smooth the greater irregularities of the surface of the new bone.

Bast and Sullivan have recently completed some experimental work on the repair of bone. They call the osteogenetic layer of the periosteum the "cambium layer." They also refer to two types of bone dissolution, i.e., with and without the presence of osteoclasts.

The osteogenetic cells that line the marrow surface of the bone, those lining the haversian canals, and those constituting the cambium layer are the most important in the repair of bone. The cambium layer exhibits the most important changes during the beginning of the repair process. During the second day, already the cambium layer becomes thickened through the multiplication of its cells. At first the cells are of the simple squam-like type. These later become cuboidal and then stratified to six or more layers. Spicules of bone are next formed in this cambium on the underlying bone. These changes involve one-eighth to one quarter of the circumference of the bone on each side of the saw cut. If the cambium is injured much in the cutting, then the callus is usually formed by the uninjured cambium. The formation of the callus is rapid during the fourth to the fifteenth day. Over the ends of the cuts the formation continues until the eighteenth day. The enlarged cambium farthest from the cut becomes reduced as early as the ninth day when

anterior margin is not noticeably decreased in thickness, there are many enlarged canals near the marrow cavity and then others scattered through to the periosteal surface. The lateral wall is somewhat thinner than usual and there are many enlarged canals extending throughout the entire anterior wall. Apparently one group formed a line to the periosteal surface weakening the bone, thereby causing it to break at this point during grinding.

In the advanced stage the entire bony shell is thinner and the areas of the destruction are readily noted with the unaided eye.

Figure 8 shows an example of extensive alteration. The marrow cavity is shown at *M*, but the many enlarged canals are as yet not in continuity therewith. One can see the many normal canals and haversian systems throughout the section, on the one hand, and several enlarging canals (in the early stage) at *a, a*, on the other hand. The numerous large irregular areas *c, c*, are produced by the destruction of the interstitial lamellæ between several destroyed systems causing these cavities to become confluent.

One can readily appreciate the condition when those spaces near the marrow cavity become connected therewith. The marrow cavity becomes larger and the bony wall thinner, weaker, and less resistant to strain. As these areas form in the remainder of the bony wall it becomes porous and fragile.

The changes may be summarized as follows:

1. Dissociation of the organic and inorganic constituents of the haversian lamellæ.
2. The appearance (deposition?) of granules in the lamellæ.
3. Extensions of the deposits to the periphery of the system.
4. Absorption and disappearance of the lamellæ from within, outward.
5. Widening of the canals and thinning of the system.
6. Disappearance of the haversian systems and the formation of irregular spaces.
7. Decrease of diameter (?) thickness of bony wall, weight and strength of the bone.
8. Increased medullary index.

At the onset these senile changes show only in the haversian systems. Why they should start here and not elsewhere is not definitely

known. These changes may be connected with the blood supply variation or may be due to a variability in the chemical stability of the bony substance or to both. The blood supply might be affected by arteriosclerotic changes in the blood vessels. The circulation is more complicated in the third type of bone and so it would more readily be subject to structural variation. Also those structures developed last phylogenetically are usually weakest, this fact may explain why they undergo these changes.

#### SENILITY OF BONE IN RELATION TO BONE REPAIR

We are familiar with the fact that bones are usually united by the end of the sixth week after the fracture, all things being normal. The patient begins the use of the upper extremity by that time and is merely cautioned against excessive muscle strains and muscle actions. With the lower extremity it is different. The patient does not make use thereof so soon. The fragments are, no doubt, united by that time, but they are not yet able to bear the full weight of the body, this must be done gradually.

We are also familiar with the fact that sometimes bones are united by a cartilaginous union and when the part is used, it exhibits what is called a false joint. In other words, very little osseous tissue may form in the callus. Is this due to mechanical disturbance of the parts, faulty nutrition, or is it a disturbed endocrine state or a condition due to a faulty metabolism? It would seem that, in some instances, it is due to the latter condition as that type of union is sometimes seen in alcoholics. Also in those individuals who cannot be still incomplete ossification will occur. In other words, in most cases, unless the parts are maintained in a continuous approximate state, bone formation will not be complete. The irritation due to the movements of the fragments, seems to mitigate against perfect ossification.

In the aged it is known that a mere stumble or tripping with the attendant sudden and violent muscle action may cause a femur to snap. Why? Also such patients may have a prolonged or protracted recovery and not unlikely be bedridden for the remainder of their

days? Why? Other elderly individuals may have a complete and uneventful recovery. The bones grow old just as other organs of the body may do and usually do.

Upon examining some of the ground sections it is not difficult to say which of these bones would have united completely and thoroughly. A casual examination of those that show an increased medullary cavity with the attendant thinning of the bony wall, will give one the reason why such bones readily fracture and when fractured why the union is delayed or incomplete.

There can be no doubt of the loss of strength due to the removal of part of the wall from the inside and the additional porosity of the remaining portion. It was thought that these bones fractured because they were more brittle, it seemed that older bones should have less organic material than those at the prime of life, as from ossification *in utero* to the adult period with the completion of the bone growth the percentage of organic material becomes reduced. At birth the compact bones are about 50 per cent organic material, while in the adult the organic material has become reduced to 39 per cent or 40 per cent. It would logically follow that in old age, 60 to 90 years, the organic substance should be farther reduced, but this is not the case as in the older bone the organic material is actually increased to 42 per cent.

The cause of fragility in old bone must be looked for in some other factor. According to the actual condition of increase of organic material, the old bone should be more tenacious and more elastic (properties due to the organic material). In reality the bones are more readily broken. The increase of tenacity and elasticity due to the small increase of organic content is more than balanced by the porosity and the thinning of the bony shell. This can readily be demonstrated in the slides that show the senile changes. Here, although the organic content may be higher, the bone is much weakened by the loss in thickness of the bony wall and the destruction of the canals and systems. When the destructive senile changes are advanced and marked, it stands to reason that such a bone is in no condition to give rise to normal repair activi-



Fig. 8. Ground section of the femur. The medullary canals are fairly numerous. At this stage of destruction, the early stages of destruction are evident. Several large areas of destruction merging with the medullary canal. The destruction with the involvement of medullary canals and the intervening interstitial lamellae.

ties when fractured. In consequence, although bone repair may be attempted at the fracture, bone destruction is, no doubt, still going on, and two conflicting processes are seen. With the age of the patient considered, and his possible lowered vitality, it is no wonder that he becomes bedridden.

While in some elderly persons the physiological process may be very little reduced, in others it is markedly reduced from that of the prime of life, with senile changes in the bones, indicating an altered physiology and histology, it is readily manifest that repair cannot and will not be normal.

The writer has endeavored to give an explanation as to the why and wherefore of delayed or non union in the repair of fractures in the elderly and also to give the practitioner a picture of the condition present in the prognosis naturally much delayed, and the attending physician will be unfavorable plan to the intelligent patient just why no union can be hoped for. While no cure is to be expected, it, nevertheless, places the physician upon a better plane of understanding with his patients.

The writer desires to thank Dr. J. Francis Schaeffer for his helpful suggestions and criticisms and the preparation of the illustrations.

J. L. Wade



## PYLISCOPY—RADIOSCOPY OF THE KIDNEY PELVIS

A CLINICAL AND EXPERIMENTAL STUDY<sup>1</sup>

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**R**ADIOGRAPHY of the kidney pelvis has been carried out for a number of years, but only in recent years has the pelvis filled with an opaque fluid been studied with the fluoroscopic screen. As far as the writer has been able to determine the first mention in the literature is by Fey, Truchot, and Dossot (1925), and this present work is inspired by the work of these authors.

## ANATOMY

In its lower part the musculature of the ureter consists of an outer circular and an inner longitudinal layer while in its upper part and in the pelvis of the kidney there are three layers, outer longitudinal, middle circular, and inner longitudinal, while the higher one goes more and more strands of fibrous tissue separate the bundles of smooth muscle (Cunningham). The musculature of the wall of the calyx is carried on to and becomes continuous with the muscular tissue in the papilla (Schafer). Embryologically the ureter,

pelvis of the kidney, calyces, and collecting tubules in the medulla of the renal pyramids arise from the epithelium of the diverticulum from the junction of the Wolffian duct and the posterior segment of the cloaca (Keith). It seems reasonable therefore to expect that these four sections of the urinary duct system should function more or less as a whole. The nerves to the ureter and kidney pelvis are via the renal, spermatic, and hypogastric plexuses (Cunningham) and in the dog have been traced chiefly from the eleventh, twelfth, and thirteenth dorsal nerve roots (Starling). Nerve fibers are known to enter the upper and lower ends of the ureter while throughout its length is a ganglionic nerve plexus (Starling). Engelmann states that contraction waves travel down the ureter at the rate of 20 to 30 millimeters per second.

## METHODS OF THE PRESENT INVESTIGATION

**Clinical.** A ureteral catheter of about 10 centimeters is passed up the ureter in the pelvis of the kidney and iopiodol or iodipin slowly injected with a syringe until 10 cubic centimeters have been injected or until the patient begins to complain of pain, the injection being generally carried out under the fluoroscopic screen. It is important not to continue to inject after the patient first begins to complain of pain. This point will be dealt with later. The catheter may then be slightly withdrawn, but still left well up the ureter so as to block it. The kidney pelvis may then be observed on the screen, photographs being taken from time to time. All drugs administered were given subcutaneously or intramuscularly.

**Experimental.** In all cases dogs under chloroform anesthesia were used and were killed at the end of the experiment while still

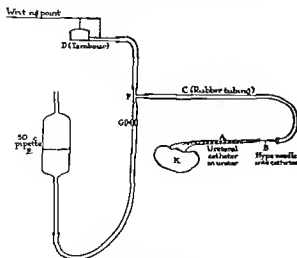


Fig. 1. Apparatus.

<sup>1</sup>From the Department of Physiology of the University of Melbourne and the Gynecological and Radiological Departments of the Women's Hospital.



Fig 2 Histamine

under the influence of the anæsthetic. In some cases a large dose of morphine (2 to 4 grains) was also given, preliminary to the chloroform anæsthesia (this is our usual procedure here in vivisection experiments).

*Pyeloscopy with the fluorescent screen* The technique was identical with that in the human being outlined. All drugs administered were given either intravenously through a cannula in the jugular vein or intramuscularly. This portion of the work was done in association with Dr H Flecker and forms the subject of a separate communication later in this paper.

*Graphic recording of contraction or relaxation in the renal pelvis* A ureteral catheter is passed up the ureter well into the pelvis of the kidney (its position being verified by subsequent postmortem examination). The method of recording is as follows. The inlying catheter, *A* (Fig 1), is connected as in the illustration by a large hypodermic needle, *B*, to a length of rubber tubing, *C*, passing to one arm

of a T-piece, *F*, a second arm of which is connected with the tambour, *D*, to which is attached a writing point the excursions of which are recorded on a moving smoked paper. The third arm of the T-piece, *F*, is connected to a 50 cubic centimeter or 100 cubic centimeter pipette half-filled with normal saline solution, the fluid level in which is kept at about the same height as the animal's kidney. Urine secreted by the kidney is accommodated in the system, and so the screw-clamp, *G*, is adjusted so that the urine secreted will be accommodated in the pipette, *E*, while any more or less sudden displacement of fluid due to contraction or relaxation of the kidney pelvis will be recorded by the writing point. In the resting condition of the kidney a plateau is thus written by the recording point, whereas if the clamp, *G*, be kept quite closed the writing point gradually and steadily rises and after a while the clamp must be released, otherwise the rubber in the tambour will be stretched so tight that it will not record. This



Fig 3 Dog's urine



Fig 4 Ergot.

Fig 5 Strychnine and atropine and atropine

apparatus was suggested by the apparatus which is used by Professor W A Osborne, of Melbourne, for recording venous pressure. A catheter which was passed into the pelvis of the other kidney was connected with a drop recorder and indicated the rate of urinary secretion.

**Results** As indicated in a preliminary note published by the author (1928), the musculature of the kidney pelvis can be seen to exhibit regular rhythmic contractions. As far as the author has been able to observe the wave of contraction commences in the upper calyx followed in succession by the middle and lower calyces at intervals of from 1 to 3 seconds. During this period the body of the pelvis (for which the name "ventricle of the pelvis" was suggested) undergoes steady relaxation. When this part of the pelvis has received the contents of the calyces the communication channels between the calyces and the "ventricle" become contracted, the "ventricle" contracts with a snap like action reminiscent of the action of the cardiac ventricle, a "globule" appears at the upper end of the ureter and is passed down the ureter by a peristaltic wave, sometimes so fast as to be barely visible and sometimes so slow that an individual globule can be readily followed in its course down the ureter (when the indwelling catheter has been previously removed, of course). Various modifications of this normal functioning have been observed—for example, in one case in which the patient had complained of vague backache it was seen that when the "ventricle" contracted some of the fluid was forced back through the communication channel to the upper calyx which became forcibly dilated and this movement synchronized with the "throbbing" pain which the patient described. In this patient it was observed that an injection of eserine sulphate (1/100 grain) restored the function to normal and at once

relieved the pain. In another case anti peristaltic waves up the ureter carried the lipiodol up the ureter into the kidney pelvis. An injection of morphine sulphate "cured" this condition.

**Action of drugs** Atropine invariably caused relaxation of the kidney pelvis with overfilling and pain in the human subject. In the dog in some cases a preliminary slight contraction was observed. Morphine, strychnine, eserine, pituitrin, all caused contraction of the kidney pelvis with instant relief of the pain caused by atropine. In the case of pituitrin, the contractions of the ureter were also accelerated to such a degree that it was impossible to see the "globule" passed down it after the "ventricle" contracted. In the experimental animal it was also found that these drugs exerted a like action although contraction was not always readily elicited when the animal was under the influence of a large dose of morphine. The marked relaxing effect of histamine (ergamine and dog's urine) (Fig 2) which also produced a marked vasodilatation with fall in blood pressure is well seen in the tracings illustrated (Figs 2 and 3). In small doses histamine produced slight contraction of the kidney musculature. Ergot (ergutin) produced a preliminary relaxation followed by a prolonged contraction (Fig 4). Strychnine produced a marked contraction while a mixture of strychnine and atropine produced a contraction followed by some degree of relaxation (Fig 5).

#### RESULTS AND CONCLUSIONS

1. Pyeloscopy gives us a ready method of determining the pathology of cases of kidney pain where lithiasis is absent. In many cases of pyelitis the author has determined by direct observation which drug gives the best contraction of the renal pelvis and the patient is kept on this for some time. As a general rule,

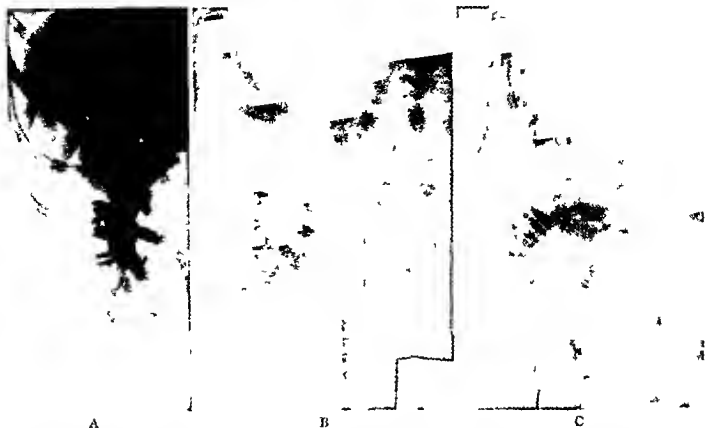


Fig 6 A Commencing subcapsular bursting of kidney, B further stage, C, control reversed in printing Experiment June 5, 1929

eserine and morphine have been found the best. Patients who had wearily dragged on for years suffering from backache with periodic exacerbations of headache, sweating, rise in body temperature, etc., have derived immediate relief from strychnine, eserine, and morphine, either alone or combined, when citrates and the usually recognized treatments have failed.

2 The cases of antiperistalsis explain how the pelvis of the kidney may be infected from an infected bladder. The pain accompanying these antiperistaltic contractions or the antidromic passage of urine suggest this as a possible cause of the cases of renal and ureteral colic simulating stone when no stone is demonstrable.

3 In cases of hydronephrosis in which the pelvis contracts well and vigorously, obviously the treatment is plication, whereas if the pelvis does not contract and is simply an inert atonic sac, then nephrectomy is obviously indicated.

4 In cases of early malignancy involving perhaps only a single calyx, the absence of

contraction of one part of the pelvis associated with "idiopathic" hæmaturia of renal origin would justify the performing of an exploratory operation.

5 The actions of the various drugs illustrated remind us that these drugs commonly administered for various specific conditions have an action and produce effects on other organs of the body, and the effect on the kidney musculature might produce unexpected symptoms. Histamine, which has come into such prominence in recent years more especially in regard to surgical shock, has a very definite physiological action on the kidney musculature. A whole vista of possibilities is opened up—what effect this action would have on the elimination of urine from the kidney itself, what influence it might have in the causation of stagnation of urine and back-working into the kidney collecting tubules, how much of the symptoms of pyelitis are due to the local elaboration of histamine-like bodies by the action of the bacteria which have invaded the kidney pelvis, what is the influence of colonic stasis with the absorption

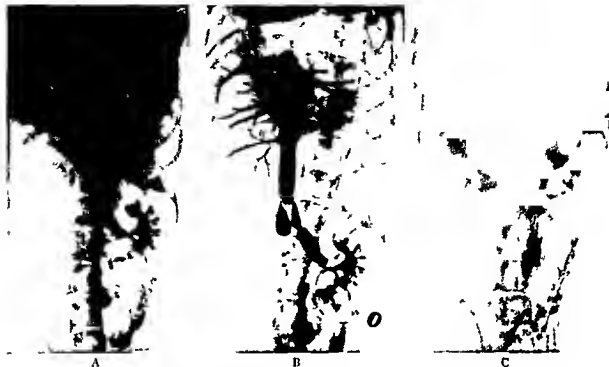


Fig 7 A Commencing injection 10 cubic centimeters of solution at 4 56 p.m. B after injection at 5 02 p.m. C control experiment May 29 1929

of sympathomimetic amines on the excretion of urine, and many other of the problems associated with the therapeutics of kidney conditions in general

6 Too much stress cannot be laid on the necessity for slowly injecting the kidney pelvis and the great danger of a rupture incurred if nature's warning of pain be ignored (In the following paragraphs is appended a brief description of the work which has been carried out by the author in collaboration with Dr H Flecker)

#### EXPERIMENTAL PYELOSCOPY IN THE DOG<sup>1</sup>

Observations with the fluoroscopic screen of the pelvis of the dog's kidney filled with an opaque fluid (lipiodol or sodium iodide solution) showed the same responses to drug action as the human, viz —relaxation with atropine and a contraction with morphine, strychnine, eserine, pituitrin, ergot, and pilocarpine

<sup>1</sup>From the Departments of Physiology and Anatomy in the University of Melbourne

A point of very great practical importance elicited in these experiments was the ease with which the kidney pelvis could be ruptured. In one case a head of pressure of about 35 centimeters potassium iodide solution (30 per cent) caused a rupture. As seen in the radiograms (Fig 7) the rupture is generally subcapsular and is usually at the lower (caudal) end of the pelvis. Very soon, however, the opaque fluid enters the veins and in one picture the fluid is seen in the intercostal veins (Fig 7). This is obviously of very great importance in the technique of filling the renal pelvis with a fluid under pressure, as when a pyelogram is to be taken in the human subject, and apparently accounts for fatal cases in which a non viscous fluid such as sodium iodide solution has been rapidly injected under pressure. Apparently the pain felt by patients when the pelvis is reaching "breaking point" is nature's warning signal and must on no account be disregarded. This question is being further investigated and it is hoped will be the subject of a further communication later.

*Details of some experiments, relative to rupture of the kidney*

Dog No 34, F, tan terrier On May 29, 1929, after a preliminary injection of 2 grains of morphine a cannula was inserted in the left ureter and 4.5 cubic centimeters of "ioran" (iodized oil) run in. Later 10 cubic centimeters was injected. Necropsy showed rupture of lower calyx of pelvis, apparently into the renal vein. The renal vein and vena cava contained drops of oily liquid.

Dog No 31 On May 15, 1929, 5 cubic centimeters of ioran was injected into each kidney through cannulas in each ureter, and then a further 10 cubic centimeters was injected into the left ureter. The X-ray picture showed a great bulge in the lower part of the kidney as if the kidney were ruptured.

At necropsy the left kidney showed a small rupture in the lower pole of the kidney from the lower calyx under the capsule. The capsule was distended with ioran on the lower and mesial (anterior) aspects of the kidney. The right kidney showed a small ecchymotic patch about 0.5 centimeter in diameter.

On May 6, 1929, potassium iodide solution (30 per cent) was run in at a head of pressure of 1 meter of the solution. In 30 seconds the pelvis was filled. In 4 minutes the kidney was found burst.

My thanks are due to Professor W. A. Osborne for the use of the laboratories of the Department of Physiology of the University of Melbourne and for his advice while this work has been in progress, to the medical superintendent of the Women's Hospital, Melbourne for placing the facilities of the hospital at my disposal, and to Sister Blyth of the radiological department of the Women's Hospital, Melbourne for her technical assistance in the clinical investigation.

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## LIPIODOL PELVIC CYSTS<sup>1</sup>

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SINCE the beginning of the use of iodized oils as opaque media for roentgen examination of the uterine and tubal cavities, there has been present the question of the effect of these oils on the mucous membrane of these cavities and on the peritoneum when spill of the oil from the tubes occurred. Sicard and Forestier, from a large experience with roentgenological exploration of spinal and cerebral spaces, genito-urinary organs, and other organ cavities, considered the injection of lipiodol non-irritating to the various cavity linings. They stated that lipiodol was a definite chemical compound, with 40 per cent iodine bound to poppy seed oil, and therefore, not a solution and tolerated by human tissues and cavities as any ordinary oil would be. They also stated that very high doses gave hardly any reaction and generally no iodism, as no free iodine was present. However, they cautioned against the use of samples of brownish color or dim appearance which indicated free iodine.

Following this reassuring study, other reports appeared. Stein and Arens, Stone and Jarcho (the latter gives a long list of references to other workers) stated that lipiodol was harmless in their experience with large series of patients.

The therapeutic use of iodized oils was then introduced in gynecology after having been used in pericardial, pulmonary, and other disease conditions. Cotte and Bertrand, in 1926, observed that lipiodol had a powerful antiseptic action and would destroy any micro organisms in the fallopian tube after intra-uterine injection. Although they used lipiodol for diagnostic purposes in a large number of cases of acute or subacute inflammation of the fallopian tubes, they never noted any rise in temperature or any unfavorable reaction due to the introduction of the oil. On the basis of these observations they suggested the therapeutic use of lipiodol early in the course of salpingitis, assuming that it might result in early recovery and prevent obstruction.

<sup>1</sup>Read before the Chicago Gynecological Society November 15, 1929.

Another favorable report was made by Cotte and Pierre, who gave intra uterine lipiodol injections in 20 cases of acute adnexal inflammation, without harm. The iodized oil was thought to have a favorable influence on the pathological process in the fallopian tube. In these reports, there was a disregard for dosage of the oils and infection of the genital tract.

In contrast to such overwhelming favorable results demonstrating freedom from danger in the use of the iodized oils, only few reported unfavorable results were reported. Odenthal had two patients who developed pathological changes from the injection of the contrast material. In one patient he injected only 4 cubic centimeters of 40 per cent iodipin. Within 10 days after the injection, a bilateral tubal infection began which subsided under conservative treatment after 3 weeks. He operated on the second patient 3 weeks after the injection. Microscopic sections of the tubes showed oil and giant cells in the wall. He thought that these cases illustrated the dangers of the use of iodized oils in spite of asepsis and indications.

Lecene and Declere report the first accidental infection of the fallopian tubes in a series of 230 observations. Descomps, Delassus, Sicard, and Solal, each had a patient who developed a pelvic infection after lipiodol injection. Descomps found lipiodol in the cul de sac of another patient, at operation, 2 months after injection.

Ries published in the transaction of the Chicago Gynecological Society a very thorough report of a case of a woman, who was operated upon 6 months after the injection of lipiodol. He found extensive adhesions between the peritoneum, omentum, uterus, bladder, sigmoid, and appendix. After freeing the omentum he found cysts and walled off fluid among the thin adhesions. The fluid was sterile and gave no iodine reaction. On the under surface of the mesentery of the small intestine there were 25 stone like formations embedded in the serosa of the mesentery. No iodine was found in these masses which had a cheese like structure held together by some strands of connective tissue. These masses were found in the adhesions of the pelvis also. In the micro-

scopic sections of the tubes, large numbers of giant cells were seen, in which were homogeneous greenish masses and granular masses.

A recent experimental study of the effect of iodized oil on serous membranes was published by Crandall and Walsh. They found that lipiodol and lipiodin were irritating to the lining of the pericardial, pleural, and joint cavities while the oils appeared harmless in the peritoneal cavity.

As there are only 2 case reports in the literature of pathological changes in the pelvic tissues (Odenthal, Ries) and only one of the presence of lipiodol 6 months after the injection of the oil (Ries), the following case of the patient with 1 uterus *bicornus unicollis* with lipiodol in the pelvis 22 months after injection during which period she delivered a full term child, is unique.

F. G., a colored woman 23 years old, entered the obstetrical department of Cook County Hospital on September 21, 1929. Her chief complaints were pain in the lower abdomen, of 4 years' duration, but aggravated in the last 2 months, and a yellowish white vaginal discharge of 5 years' duration. Her description of her complaints was that of chronic adnexal disease. Menstruation occurred irregularly, at 4 to 6 weeks' intervals for the last 6 months lasting 7 to 10 days. The flow was profuse and was associated with lower abdominal pain. In 1925, she delivered a premature child (7 months).

On August 18, 1927, although only 8 months pregnant, she had brought on labor by taking castor oil for constipation. She was seen by me for the first time after having been in labor for 13 hours with the bag of water ruptured for 8½ hours. Examination showed a normal full term baby in the right occipito posterior position, head high due to an irreducible obstructing mass, which was being further impacted into the left side of the pelvis by the presenting part. A low transverse cesarean section was performed complicated by a short longitudinal laceration upward in extracting the head manually. The obstructing mass was found to be the left horn of a bicornuate uterus flexed laterally and forced into the pelvis by the head. At this time, gonococci and streptococci were found in the vagina. The Wassermann reaction was positive. She developed a puerperal fever (acute metritis, septicemia) which responded favorably to therapy which included puerperal fever streptococcus antitoxin. The premature labors may be attributed to the uterine anomaly rather than to the lues because of the normal appearing placenta. This characteristic of bicornuate uterus has been described and emphasized by Gail.

The patient returned in October, 1927, and a late secondary luetic skin eruption with cervical lesions

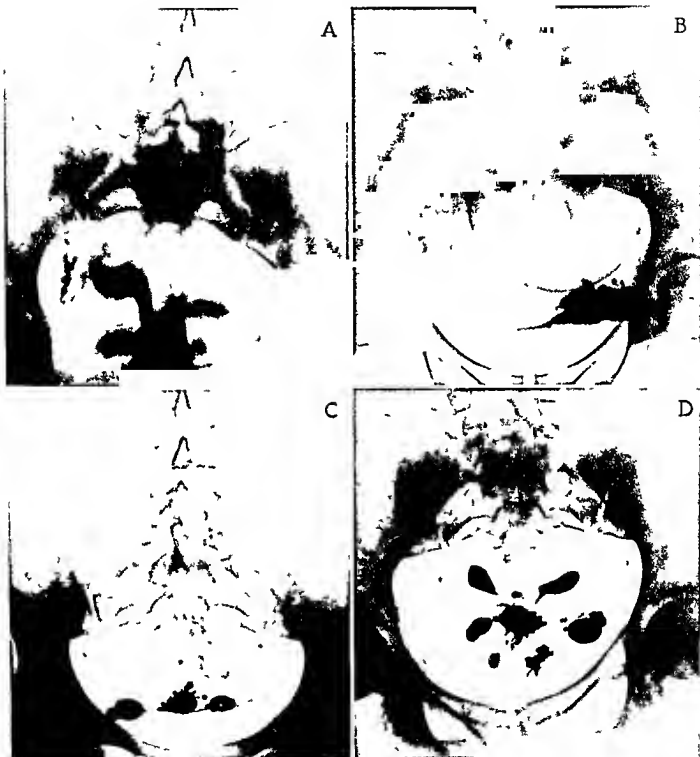


Fig 1 Roentgen plates of A, pelvic viscera after lipiodol injection, December 27 1927 B, fetal head in pelvis lipiodol in pelvic cavity, October 28, 1929, C, pelvis and lipiodol

cysts, September 14, 1929, and D, pelvic viscera after lipiodol injection, September 14, 1929

was found. She was given a course of antiluetic treatment. The cervical discharge subsided and smears did not show any gonococci on December 3, 1927. Lipiodol (6 cubic centimeters) was injected into the uterus and a roentgen plate was made but proved unsatisfactory. Therefore, on December 7, 1927, 10 cubic centimeters of lipiodol was injected

and roentgen examination showed the two uterine cavities, larger than normal, patent tubes, and some of the oil in the pelvic cavity. Following this examination the patient was observed for weeks and no apparent complication developed.

In June, 1928, the patient came back again because of pain in the lower abdomen. Bimanual





Fig 2 Photomicrograph of cyst wall illustrating histiocytes and giant cells  $\times 325$

examination found the left horn pregnant. Roentgen examination showed that lipiodol was present in the pelvic cavity. In October 1928, the roentgen plate showed a well developed fetus to the left and lipiodol in the pelvic cavity. On December 26 1928 patient began to experience labor pains and she went to the door to call for a taxicab when she had one strong pain fell on the floor, and a full term normal baby was born precipitately. As she stayed at home the details of the puerperium were unknown. Pain in the lower abdomen as described forced her to return for local treatment.

As to her past history she has had measles, malaria and typhoid fever. There was nothing of significance in her family history. All three pregnancies were illegitimate.

Physical examination November 21 1929 revealed a well developed well nourished colored female about 25 years of age having a normal temperature pulse and respiration. The essential findings were the abdomen was round firm and elastic with a subumbilical midline keloid scar no masses or rigidity were present but definite pain was produced by pressure in the iliac fossae. On vaginal examination the vulva was found normal the pelvic floor was firm and elastic the cervix was hard and round but its regularity was interrupted by an anterior septum 4 to 5 millimeters thick extending along the anterior surface of the portio and anterior vaginal wall. The external os was patent with a depression posteriorly. The corpus was represented by two firm cylindrical masses about 5 to 6 centimeters long and 3 to 4 centimeters in diameter, lying high in the pelvic cavity being fixed and tender on motion. The adnexa bilaterally were fixed and tender but no masses could be defined. Speculum examination showed the cervix with a simple erosion and the anterior vaginal septum. Urinalysis revealed no pathological findings. Wassermann was negative. The diagnosis was

made of bilateral chronic salpingitis with healed pelvic peritonitis with retained masses of lipiodol. On September 14 1929, roentgen examination of the pelvis showed lipiodol still present. Lipiodol was injected again, demonstrating the two uterine cavities with closure of the tubes at their uterine ends in addition to the old lipiodol masses.

A laparotomy was performed on September 23 1929. When the abdomen was opened the omentum was found firmly adherent to the parietal peritoneum anteriorly near the lower end of the wound to the right uterine body and adnexa to several cystic masses in the anterior cul de sac, to the point of fusion of the two horns of the uterus and to the top of the bladder. The adhesions were firm, and in order to free the omentum sharp dissection was necessary. The three cystic masses found in the interstices of the adherent omentum in the anterior cul de sac varied in size from about 1.5 centimeters to 3 centimeters in diameter. The two smaller ones contained a clear, light amber oily fluid while the larger one contained a dark brown oily fluid with yellow flakes which came from the lining of the cyst wall which was about 1 millimeter thick.

The bicornuate uterus was high in the pelvic cavity lying just above the sacral promontory. Both tubes were thickened, firm, tortuous and bound down with firm adhesions to their respective ovaries. The fimbriated end of the right tube was open. The right ovary was larger than normal made up of multiple small cysts and one hemorrhagic cyst. A supra-cervical hysterectomy, bilateral salpingectomy, and right oophorectomy were done. The convalescence was uneventful except for an acute pyelitis and wound hematoma. The patient left the hospital in good condition. Microscopic sections of each corpus uteri showed an edematous resting endometrium, a thickened myometrium with areas of round cell infiltration which were also present in the serosal adhesions. Sections of the ovary showed multiple follicular cysts and one corpus luteum. The sections of the isthmus and ampullar portion of the right fallopian tube showed subepithelial and perivascular round cell and plasma cell infiltration. The section through the lipiodol cyst showed a thin connective tissue capsule lined with histiocytes, and outside of the capsule two foreign giant cells were seen in a smaller cyst.

The oil in the cysts was sterile and gave no iodine reaction. However, on breaking the lipiodol down (according to the instructions given in the *New and Non official Remedies* 1928 page 14 for iodipin) a positive reaction for iodine occurred. The yellowish white flakes found in the oil and on the surface of the cysts were amorphous under the microscope.

#### SUMMARY AND DISCUSSION

From an analysis of the history and clinical course of the conditions and pathology in this patient, one is lead to separate the various entities. There was a chronic bilateral salpingi-



Fig 3 Photomicrograph of fallopian tube illustrating subepithelial round cell infiltration  $\times 85$



Fig 4 Photomicrograph of the endosalpinx illustrating chronic inflammation  $\times 325$

tis with healed pelvic peritonitis in which gonococci and streptococci probably played a role. Also the lipidol had produced a foreign body reaction in the pelvis with the formation of cysts and giant cells independent probably of the pelvic infection. The intimate association of the omentum and the lipidol may indicate that it plays an important part in the removal of the lipidol from the pelvis. Schochet mentioned this function of the omentum in discussing Ries' report. After the lipidol injection, the tubes were functionally competent since pregnancy occurred one year later. With repeated infections as might be expected in this type of individual, the tubes were finally closed at the uterine ends (salpingitis isthmica nodosa), as demonstrated by the last roentgen plate. The lipidol was sterile and gave a positive reaction for iodine only after it was saponified, thus indicating chemical combination rather than solution of iodine in poppy seed oil. In considering the large number of favorable reports with absence of complications after the injection of iodized oils into the uterus as compared with the very few reports of complications one is impressed with the harmlessness of these oils in the pelvic structures. The absence of follow-up in many cases, however, may explain this apparent infrequency of complications although the iodized oils are so generally used.

That the lipidol is antiseptic is questionable because the iodine is in chemical com-

bination and therefore not free to act and because the oil does not mix with liquid media. In order to test the antiseptic value of lipidol I mixed equal parts of lipidol and a 24 hour broth culture of streptococci in one tube, and of colon bacilli in another tube. Control tubes of equal amounts of broth culture of these organisms were used. The oil culture mixtures were shaken for 3 to 5 minutes and all the tubes were incubated for 24 hours at 37.5 degrees C. After the mixtures were again shaken, subcultures were made on blood agar plates which were incubated for another 24 hours. The number of colonies on the plates from the controls and the lipidol culture mixtures was the same. It was evident that the oil and the broth did not mix but the shaking would be expected to bring small particles of the oil in contact with the bacteria. The lipidol did not inhibit growth although bacteria did not grow in it as it remained clear. Also Dr. I. Pilot has informed me that he has used lipidol to help produce lung infections by keeping the introduced bacteria in the bronchioles. Therefore, the antiseptic properties of lipidol are still to be proved. In intra-uterine injections the oil may well force or carry along with it infected secretions from the cervix or tubes into the pelvic cavity to produce an infection which varies in its severity. The acute types become apparent early, while low grade infections over a long period of time may be symptomatic.

The cases of Odenthal, Ries, and the one here described would suggest a foreign body reaction in the pelvis to lipiodol. I believe that there are two possible explanations for this reaction. First, there may be sufficient free iodine to be irritating and yet not grossly visible or the oil acts as a foreign body in some patients. Second, in the presence of old pelvic adhesions, the peritoneal surfaces may be so changed that there is a decreased vascularity. The response of the histocytes or macrophages may be insufficient to cope with the amount of lipiodol to be phagocytized. Therefore, the fibroblasts form around these masses with the surrounding macrophages and wall off the foreign body. The omentum takes part in this walling off process. The possibility of producing a foreign body reaction by the lipiodol cannot be utilized as an argument against its use since this complication is rare in comparison with the frequency with which lipiodol is used. The danger lies only in the use of the chemically changed sample of the oils or in the presence of infection of the genital tract.

Although further studies are necessary to settle the problems discussed, the following conclusions may be made from an analysis of previous case reports and the present case:

1. In a case of uterus bicornis unicollis with lateral chronic salpingitis and healed pelvic peritonitis occurred independently of the foreign body reaction produced by the presence of lipiodol in the pelvic cavity. The function of the tubes was not disturbed by the lipiodol as the patient delivered a full term child one year after injection.

2. In the presence of infections of the female generative tract, the use of iodized oils is contra-indicated as their antiseptic properties have not been demonstrated.

3. In some individuals lipiodol may induce foreign body reaction in the pelvis but it is

also true that some specimens of lipiodol (free iodine) may be irritating to any peritoneal surface.

4. The great value of iodized oils in roentgen examination of the female pelvic organs should be appreciated but due precautions in its use must be observed. It is suggested that the oils be tested for free iodine and that oil injections be used only in the absence of infections of the female generative tract.

I wish to acknowledge the great help rendered by Miss Louise Montgomery of the Social Service Department of Cook County Hospital in following this patient.

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## URETHRAL CARUNCLE IN THE FEMALE

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IN routine pathological diagnosis, some cases of relatively minor importance seem more perplexing than frankly malignant conditions. One of these border-line conditions is the so called "caruncle" of the female urethra. In this location, the infolding of the epithelium is marked enough to raise the question of carcinoma, although no carcinoma exists. Before considering the pathological changes, a review of the development and normal histology of the urethra is necessary.

## EMBRYOLOGY OF URETHRA

By the fourth week of intra-uterine life, the cloaca is formed from the entoderm near the posterior pole of the embryo, and this gives origin to the allantois (Keith). By the seventh week the entodermal cloaca is represented practically exclusively by the urogenital sinus. Later, separate openings develop in this to form, in the female, the vagina and urethra. According to Wood-Jones the female urethra represents the cloacal remnant in its simplest form, but others believe that the trigone of the bladder also arises from the cloaca. In either case, the bulk of the bladder develops from the allantois.

## ANATOMY AND HISTOLOGY

The female urethra is composed of three layers: the mucosa, submucosa, and a muscular coat. In the mucosa are numerous small glands. The submucosa contains cavernous tissue, and near the meatus the two para-urethral glands of Skene. The muscular coat has an outer circular layer of smooth muscle, which is thickest at the bladder, and an inner longitudinal layer. Veins are present between these (Morris). At the vestibular orifice is the external sphincter, formed of striated muscle (Schaefer).

"The epithelium itself," says Kaufmann, "shows marked individual variations, being composed of layers of squamous epithelium (lower part), or of transitional epithelium (above)." Bailey refers to it as stratified squa-

mous epithelium of transitional type near the bladder, then two-layered stratified, or pseudostratified, and, exteriorly, stratified squamous epithelium. According to Lewis and Stoeck, the epithelium has been variously described as stratified, with outer squamous cells, or as pseudostratified and columnar. It may be of different forms in different individuals. The lumen is irregularly crescentic with longitudinal folds.

We have studied transverse and longitudinal sections of several normal female urethras. In these, the epithelium of the inner end seems to be indistinguishable from the transitional epithelium of the bladder. That of the meatus has shown both fairly typical squamous and transitional epithelium, sometimes both in the same transverse section. We have found no evidence of hornification to differentiate the two types clearly, but the scale-like shape of the cells of the superficial layers of the squamous epithelium is quite unlike the polygonal cells of the transitional type.

## PATHOLOGY

The urethral caruncle or vascular tumor of the meatus was first described by Samuel Sharp in 1750. It is a growth of the lower half of the external orifice, florid or dusky red. It is pedunculated, or on a broad base, says Kelly, who describes the papillae, the dilated vessels, and the pavement epithelium. He says that the presence of an unusual number or arrangement of nerve fibers has not been demonstrated. Schroeder, in a recent publication refers to the dilatation of the vessels, the plasma cell infiltration, and the fact that in all of his 6 cases, the epithelial thickening is of stratified squamous epithelium. The vascular element is also emphasized by Conrad, Ferrier, Howze, and Schmitt (12, 13), while Young seems especially insistent on the chronic inflammatory changes. Kaufmann says "The so-called 'urethral caruncles' which appear in women close to the orifice of the urethra and project from the surrounding



Fig. 1. Case 1. A characteristic picture of urethral caruncle showing transitional epithelium, chronic inflammation and numerous vessels (X 40).

surface, are outgrowths of mucous membrane, they take on the character of granulomata and partly of hypervascular papillary, or telangiectatic mucoid polyps, they may reach the thickness of a small finger and a length of several centimeters and prolapse from the urethral orifice. They often contain adenoid tissue and glands, possibly cystic."

Ewing says "A common error in the diagnosis of urethral carcinomata in the female results from the deep normal invaginations of the epithelial lining of this structure. On section, these invaginations may appear as displaced islands of atypical epithelium, strongly resembling epithelioma."

In the past few years we know of two cases in which extensive operations have been performed for benign urethral caruncle because of erroneous diagnoses of epithelioma. The records of the New York Hospital do not show a single case recorded as carcinoma of the female urethra.

The etiology of caruncles, as described in the literature, seems uncertain or varied. Childbirth, apparently chiefly through its relation to infection, seems to predispose, as does also gonorrhoea. The most likely age of origin is described as at or about the menopause. The chief complaints are usually marked dysuria and frequency.

#### CASES STUDIED

Of the 23 specimens we have studied, 3 will be referred to separately, the others only in a tabulation of the entire series.

**CASE 1.** No. 12 068 a patient of Dr. L. L. Fulkerson's Cornell Clinic, was a married woman of 60 (in 1927) who has had several children the last 18 years previously. Venereal history was negative. She has been treated at the general medical clinic for constipation etc. since 1922, but the first observation relative to the bladder or urethra was made in October, 1925. At that time there were symptoms of frequency and pain on urination and a diagnosis of "prolapse of urethra" was made by one of Dr. Fulkerson's predecessors. Silver nitrate was applied twenty one times in the next 16 months, without relief of symptoms. When first seen by Dr. Fulkerson March, 1927, he made the diagnosis of "urethral papilloma" of the left posterior margin of the urethra, and the specimen was regarded by him as possibly malignant. The laboratory found chronic inflammatory changes only, with a picture similar in all respects to that shown in Figure 1. Two weeks later, the papillomatous growth was completely removed and the base cauterized. There were several fairly large papillary projections.

The tissue received in the laboratory consisted of two soft papillary masses of light pink tissue each about 2 millimeters in all diameters. Microscopically (Fig. 1), the epithelium of the specimen was transitional in type with rarely over three or four cells in its thickness and was infiltrated with polynuclears. The stroma showed much round cell infiltration and in the numerous small vessels there were many polynuclears. There was a small, branching gland like mass in the submucosa. This was lined with a single row of columnar cells, and below this there were several layers of ovoid cells. This was considered a portion of a para urethral gland of Skene. In summary, this specimen in the main showed little but the usual inflammatory reaction. However there was one area in the section (Fig. 2), which presented a different picture. Here the epithelium was markedly infolded and thickened forming a large nidus. The cells of this mass showed little or no hyperchromatism and were fairly uniform in type. They were of a fairly uniform size and showed normal orientation. No mitoses were found. There were many round cells in the adjacent stroma. Owing to the unfolding the question of possible malignancy arose but the



Fig 2 Case 1. Showing "folding" of epithelium ( $\times 40$ ) in a benign urethral caruncle



Fig 3 Urethral caruncle with gland of Skene in the submucosa ( $\times 38$ )

case was referred to Dr Ewing, who diagnosed it as entirely benign.

When last seen, 8 months after the operation, the case was pronounced "cured." There was no evidence of recurrence, and all symptoms had disappeared.

CASE 2 No T113, 1927 A woman of 55 years was purported to have had removed 6 years previously a caruncle of the same type as that of the present growth. Dr W S Hastings sent the slide to Dr Ewing, who confirmed Dr Hastings' findings of a benign process. The epithelium was thickened, transitional in type, and the picture was similar to that in Figure 2. The course was subsequently uneventful with no symptoms or signs 8 months later.

CASE 3 No T173, 1927 A woman of 63 years of age had a caruncle of the urethra. In this case also a slide was sent to Dr Ewing by Dr Hastings and again the epithelium was found to be of the transitional and infolded type, and the picture resembled that shown in Figure 2. A good deal of acute inflammation was present in the stroma, and there was one small acinar gland lined with columnar cells. Some of this lining layer of cells contained drops of mucus. The diagnosis was caruncle. The subsequent course was uneventful, with no signs or symptoms 7 months later.

#### SUMMARY OF CASES—CLINICAL FACTORS

We have collected 23 cases of caruncle which number includes 19 cases from the New York Hospital, in which the slides were satisfactory and the history fairly complete. The 3 cases of which brief summaries are given in this article are included in the tabulation.

The ages of the 21 women varied from 23 to 55 years, the average age being 51 years.

In the 15 cases in which information regarding the marital status was available, we find 10 married with children, 3 married without children, and 2 unmarried women.

No history of venereal infection was noted.

The duration of symptoms of burning and dysuria was noted in 18 cases. In one case each, this had lasted 16, 14, 12, 7, and 6 years. Most of the remaining cases complained of symptoms for a period of about 1 year. The shortest history was  $1\frac{1}{2}$  months.

Complications which were noted are six instances of relaxation of the pelvic floor with

several additional cases in which this condition seemed probable, two of hemorrhoids, (one developing a carcinoma of the sigmoid within a year), one of diabetes, one of cystitis

No case of recurrence of the caruncles has been described in the histories, which for the most part are filed in such a way that readmissions for any cause would be entered on the original histories. As noted above, in Case 2 the tissue studied was the second caruncle removed. This seemed to have occurred in only one other case studied.

#### PATHOLOGICAL FINDINGS

We have previously mentioned the fact that the epithelium which is found near the meatus may be of a fairly characteristic stratified or transitional type. In our 23 cases, 10 were found in which each type seemed predominant, while in 3, both were found in about equal proportions. This factor would be expected to vary depending on the direction in which the section was cut and the part sectioned.

With regard to the aforementioned apparent epithelial "infolding," there were 6 cases in which this was found in notable amount. Of these, 5 were tabulated as specimens in which transitional epithelium predominated. The apparent displacement of the cells downward was probably the feature which aroused the suspicion that the growth was not definitely benign. The absence of definite invasion of the subjacent structures, the uniformity as regards size and appearance of the epithelial cells, and the fact that for the most part they were properly oriented were all features which should dispose of these suspicions. The clinical data in our own cases and those reported in the literature and the extreme rarity of primary epithelioma of the female urethra further supported the position that these were benign conditions.

In 17 of the 23 cases, a definite glandular mass was present in the submucosa. These were acinar in form, and their inner lining was made up of a single layer of columnar cells. One is depicted in Figure 3. In our opinion these glands could not be confused with any other structure, and we believe them to represent glands of Skene. The high percentage of

these glands seems to suggest that they may be an important factor in the formation of caruncles. This possibility seems the more likely when it is considered that the glands of Skene and the caruncles both occur, in almost all, if not all, cases in the posterior urethral quadrants.

Transitional epithelium predominated in 9 of the specimens in which the glands were found, stratified epithelium in 6, and both in equal amounts in the other 2.

Chronic inflammation was the rule, definite round cell infiltration of the stroma being found in 21 of the 23 cases. At least moderately enlarged vessels were found in 14 of the specimens.

#### SUMMARY

1. The epithelium of caruncles of the female urethra frequently shows enough infolding to make their actually benign nature appear doubtful to one who is not familiar with this particular structure.

2. Compound acinar glands similar to those described by Skene are frequently present in the female urethra. They are found in 17 of our 23 cases.

3. It is suggested that these glandular structures may be an important factor in the formation of caruncles.

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## BRAIN-FLAP—ITS RELATION TO INTRACRANIAL PRESSURE

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THE work here reported is a continuation of that described in our earlier paper (5). At the time of its completion we had been unable to obtain results sufficiently consistent to determine what might be the relationship between intracranial pressure and the appearance of the extensive movements of the brain and dura mater with respiration which we have termed "brain-flap." This whole question, therefore, was left open pending further experiment. We had, however, observed in an early endeavor to lower intracranial pressure that the largest cerebral movements of which we had record occurred in tracings made after the intravenous administration of a hypertonic solution. This and other methods of altering intracranial pressure have given us clear and consistent results in the further investigation of brain-flap which will be described in the following pages.

## CLINICAL EXPERIENCE

Before these further experiments had been performed, an opportunity occurred of observing in man the association of brain-flap with a reduction of intracranial pressure.

During a cerebellar exposure made by one of us (A K H) for tumor, the occipital dura mater was found to be very tense and quite immobile. To relieve the tension before opening the membrane, a serum needle was passed into the hinder part of one lateral ventricle and was left there to drain off the cerebrospinal fluid. The flow from the needle was forcible at first, but afterward issued in drops which were more frequent when the patient strained. Within a few minutes from the time of the ventricular puncture and before the slackened dura mater had been opened, brain-flap made its appearance and soon increased to large dimensions.

The operation was performed under local anesthesia with 0.5 per cent novocain, and

throughout the procedure the patient talked or grumbled almost continuously. He had no pain but he complained of his position on the operating table—the usual face-down position with the head and shoulders supported—and though he suffered from no respiratory difficulty, respiration, none the less, was constantly modified throughout by his grumbling commentary.

The act of opening the dura mater did not increase the range of the movements of brain-flap but it clearly revealed the large excursions of the cerebellum, which bulged into the wound on expiration and receded deeply with each inspiratory act. These movements were seen for about half an hour and continued at a maximum until they were hidden by the suture of the muscular planes at the close of the intervention.

The level of the systolic blood pressure, recorded at intervals of 5 minutes from the brachial artery, remained remarkably constant. It is noteworthy that it stood at 110 millimeters of mercury (a) before the appearance of brain-flap, (b) at the time of its appearance, and (c) during almost the entire period in which maximal excursions of the cerebellum were observed. At the close only of the operation, the blood pressure fell to the level of 95 millimeters of mercury.<sup>1</sup>

## EXPERIMENTAL METHODS AND RESULTS

Broadly speaking, the methods employed for recording the blood pressure and variations in the intracranial volume, etc., have remained unchanged from those described in our former paper. A few slight differences of detail exist. The volume recorder used for the present work has a sensitivity almost exactly half that of the instrument used before. A movement of one centimeter of arc corre-

<sup>1</sup>This case was briefly mentioned in a footnote to our previous paper (5).



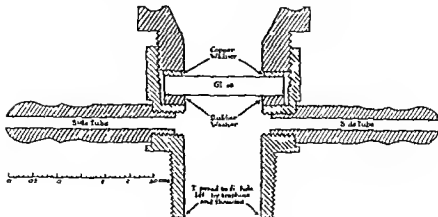


Fig. 7 This is a scale drawing of one of the brass instruments used. Taken in conjunction with the description in the text it is self explanatory and no further details need be given

sponds to a change of volume of 0.1 cubic centimeter

The single brass instrument, described before, which was screwed into the trephine opening, has been replaced by a pair of improved design, made specially for this work by Mr S W Bush of the Sir William Dunn Laboratory of Pathology, Oxford

A scale drawing of one of them is shown as Figure 7. Each consists of four pieces of brass. One of these—the largest—was bored throughout its length and tapered at one end so as exactly to fit into the conical hole left by the trephine. On this taper a screw thread was turned. At its other end, the brass piece was bored out to a considerably larger diameter and on the inner surface of this wider portion a screw thread was turned. At opposite points on the cylindrical outer surface, two holes were drilled and tapped and into these were fitted two side tubes. On the shelf left in the first piece where the bore had been widened, were fitted first a rubber washer then a circular piece of glass and finally a copper washer. The fourth piece of brass was turned to fit the screw thread in the wider part of the first piece. When this fourth piece was firmly screwed home into the first there resulted a completely air tight joint, thus leaving a potentially closed cavity below the glass, communicating with the external air by the two side tubes. The glass plate enabled one to observe the movements of the dura mater

The experiments to be described fall naturally into three groups, under five headings: the first group dealing with lowering of the intracranial pressure by two different methods, the second with raising that pressure—again by two different methods,<sup>1</sup> and the third with the results produced by the sudden reduction of an artificially created high intracranial pressure.

A fourth group, totally unconnected with the others, has been added to complete the picture given in our earlier paper of the relations between brain flap and arterial pressure.

#### *The Effects of Lowering the Normal Intracranial Pressure*

*The results of hemorrhage.* It was shown by Dixon and Halliburton and confirmed by Becht that the withdrawal of a considerable volume of blood from an animal was followed by an immediate reduction of the intracranial pressure.

This simple procedure was clearly the easiest method of testing the effect of a reduced intracranial pressure in the production of brain flap there being nothing more than a mechanical change in that pressure to be considered. (1) Using this method we found by experiment that tracheal occlusion could elicit brain flap in animals previously refractory almost immediately after removal of from 10 to 15 per cent of their blood. This may be well seen in Figure 2.

*The results of injection of 30 per cent solution of sodium chloride.* It was first shown by Weed and McKibben, and their work has been confirmed by many others, that the intravenous injection of

<sup>1</sup>It was remarked by Hill that in theory at any rate a high intracranial pressure would tend to damp out by merely physical means any changes in brain volume whether caused by variations in the conditions of the respiratory or circulatory system.



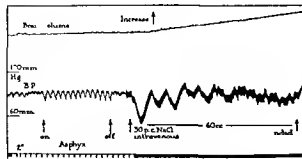


Fig 3 In this tracing may be seen the primary result on brain volume of the intravenous injection of 60 cubic centimeters of 30 per cent sodium chloride. The effects on blood pressure are also seen. During the administration there is a progressive increase of the brain volume. The solution was run into the femoral vein in amounts of about 4 cubic centimeters at a time at intervals of about one minute. In the earlier part of the administration each injection is followed by a marked drop in blood pressure but later this pressure is maintained.

movements of brain flap are very small but that soon they return again to a comparatively large size. On the further injection of water, however, they are almost completely abolished and so remain for the rest of the experiment.

*The effect of the mechanical application of an increased pressure to the brain.* For these experiments the preparation of the animal was varied in that it was trephined on both sides of the skull. Into each hole was screwed one of the two brass instruments (Fig 1). Of these one was connected as usual to the volume recorder, the other—by one of its side tubes—to a source of air pressure and to a water manometer. The air pressure was obtained by means of two aspirator bottles, each about half filled with water. These were so connected that by raising one of them a pressure could be exerted on the brain the degree of which was measured by the water manometer. The air pressure on the brain could be reduced instantly to atmospheric level by opening the spring clip which closed the rubber tubing placed on the second side tube of the same instrument to which the source of pressure and the manometer were attached.

Brain flap was induced after withdrawal of blood and when the condition was well established the effects of external pressure were examined. At first and for some considerable time only the most inconsistent results were obtained. In two experiments in which, so far as we could observe conditions were identical we would obtain results diametrically opposed. In one it would be found that the movements of brain flap were completely suppressed by a pressure of 9 centimeters of a pressure of 20 centimeters of water would only partially arrest them. It was by no means clear what the source of these inconsistencies could be. Finally, it was thought possible that there might be some variation in the firmness of the attachments of the dura mater

to the skull. It may be stated in parentheses that, in the dog, these attachments over the parietal region may be fairly strong. As a result of these considerations, in the later experiments the effect on brain flap of a pressure applied externally was examined (a) with the dura mater untouched, (b) with the dura mater freed from its attachments to the skull and (c) with the dura mater opened. Figures 8, 9 and 10 have been prepared to illustrate these experiments.

In Figure 8 is shown the effect of the application of a pressure of 5 centimeters of water to the untouched dura mater. The brain volume lever instantly rises slightly and the excursions of brain flap are merely reduced. In Figure 9, the results of the application of a pressure of 10 centimeters of water are shown. The excursions of brain flap are here virtually abolished.

In Figure 10 is shown a composite tracing in three parts a, b and c. Here a pressure of 9 centimeters of water was applied in each case. In Figure 10a there is only a small rise of the brain volume lever and little reduction of brain flap, the dura mater having been left untouched. In Figure 10b the rise of the brain volume lever is more marked and the movements of brain flap cease almost completely. In this case the dura mater was freed from the skull. The degree of difference in the appearances in Figure 10c, with the dura mater opened and those in Figure 10b with the membrane freed but intact is not great.

#### *The Effect of the Sudden Release of a Considerable Degree of Pressure Applied Externally to the Brain*

For these experiments the preparation of the animal was exactly similar to that described in the last section except that no blood was withdrawn. The animal was first tested for brain flap which was found to be absent. Pressure was then applied to the dura mater to a degree which would not affect the medullary centers. At intervals of about 10 minutes the tracheal cannula was occluded without eliciting any appearance of brain flap. When the increased pressure had been maintained for an hour, the air entry was again blocked and again no brain flap was produced. While powerful respiratory movements were still continuing the pressure was suddenly lowered to atmospheric level by opening the side tube of the brass instrument. There was then an instantaneous development of brain flap. At intervals of 5 minutes for a further period of half an hour the animal was again tested for brain flap, and it was found that the excursions of the lever became gradually smaller. Figure 11 has been prepared to demonstrate the instantaneous appearance of brain flap when the external pressure is suddenly reduced.

#### *The Effects of Brain flap on the Pressure in the Circle of Willis*

This part of the experimental work has no connection with the foregoing but was performed in connection with the study of the effect of brain volume on blood pressure. It is produced by the bulging of the brain at the trephine hole or points to that where the brain is compressed.

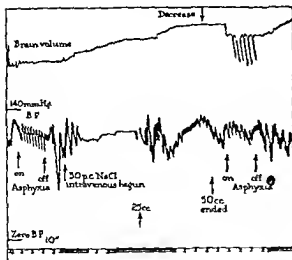


Fig. 4 This tracing is continuous, showing the whole period of injection of 50 cubic centimeters of 30 per cent sodium chloride. In the first part, "asphyxia" is not associated with brain flap. There is the same increase in brain volume and effects on blood pressure as in the previous tracing. Immediately after the injection has been completed "asphyxia" produces brain flap. The sustained height of the brain volume lever does not imply a sustained increase in brain volume. Its maintenance is due to hemorrhage into the brass instrument which accompanied the primary increase of brain volume (see also the legend to Figure 11).

order to complete the picture, given in our earlier paper, of the relations between brain flap and arterial pressure. A cannula was inserted into the cephalic end of one of the carotid arteries and connected to a mercury manometer. In this manner a tracing was prepared illustrating the changes of blood pressure in the circle of Willis which occur during the production of brain flap. This tracing showed, as had been expected, that these changes closely reproduced the ordinary asphyxial variations recorded in the femoral artery, though the actual size of the variations was smaller. In Figure 12 is shown a tracing displaying these observations.

#### DISCUSSION

It will, perhaps, be advisable first to consider a simple analogy. Let us suppose that an almost inextensible watertight bag has been made, provided with (1) a means of connection to a source of water under pressure, (2) a valve which can be closed but which, when opened, will permit a very small stream of water to escape, and (3) a cylinder with a very close fitting piston, which can be moved in and out through a short stroke (see Fig. 13). When the bag is filled with water under pressure, movements of the piston in and out in the cylinder—supposed to be small in comparison with the volume of the bag—will produce

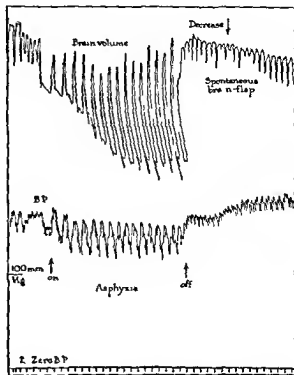


Fig. 5 This tracing was prepared from the same animal as that used for Figure 4. It shows exceedingly large movements of brain flap during a period of "asphyxia." After the release of the tracheal cannula, the animal had very marked hyperpneic respirations, which caused aspiration from the brain of sufficient blood to give rise to smaller movements of brain flap.

only very slight variations in the total amount of water in the bag itself and consequently there will be no appreciable movements of the tense wall of the bag. Now suppose that the needle valve be opened. A very small stream of water will escape and after a time the pressure within the bag will fall nearly to the atmospheric pressure. At this point, movements of the piston outward will bring down the pressure within the bag considerably and when this pressure falls, for a moment, below that of the atmosphere the wall of the bag will collapse inward.<sup>1</sup> The maximal excursion of the wall for any given length of stroke of the piston will occur when the pressure within the bag is exactly equal to the mean atmospheric pressure without.

Let us now apply this analogy of the bag to the skull contents. Here, too, there is an almost inextensible membrane, the dura mater, which represents the wall of the bag. For the sake of simplicity we shall consider only

<sup>1</sup>Naturally under the conditions there cannot be a permanent pressure within the bag which is less than that of the surrounding atmosphere.

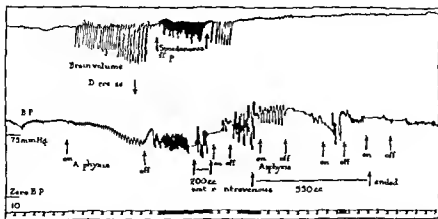


Fig. 6 This is a continuous tracing to show the effect of intravenous injection of water on brain flap. The animal had been bled and the first part of the tracing shows brain flap induced by asphyxia and even spontaneous movements due to pure hyperpnea. Two hundred cubic centimeters were first injected with the result that the brain flap movements consequent on asphyxia were reduced in size but not abolished. Very soon after the commencement of a further injection of 550 cubic centimeters of water they were found to be practically nonexistent.

the movements of the dura mater. During life and in the normal subject this membrane tends to bulge outward under intracranial pressure when an opening is made in the skull and we may for the present purpose compare

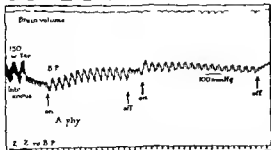
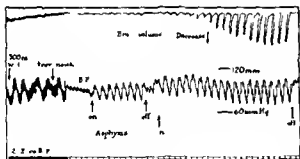


Fig. 7 This tracing is similar to the last. It shows a temporary abolition and subsequent reappearance of brain flap after the injection of 300 cubic centimeters of water. The further injection of 150 cubic centimeters reduced the movements to a minimum and for the remainder of the experiment they remained so reduced.

the contents of the dura mater to the fluid contained under tension in the bag.

The actual movements of brain flap were shown in our earlier paper to depend on the alternate acceleration and delay of venous outflow from the brain by a sufficient fall and rise of intrathoracic pressure—a fall and rise which is due to powerful respiration. The volume of the brain is in this way alternately diminished and restored. The thoracic pump thus corresponds to the piston and cylinder of the analogy, and it is clear that brain flap—which is absent while intracranial pressure is at its normal, hyperatmospheric level—may be expected to appear when the mean intracranial pressure approximates to atmospheric pressure. Then even a small aspiration of venous blood from the skull will for a moment, bring intracranial pressure below that of the atmosphere and the dural membrane will be pressed inward.<sup>1</sup>

Alternatively, a small rise of intracranial pressure due to a delay of venous outflow from the skull will now suffice to bulge out the almost equipoised membrane. It is thus obvious that the swing of the dura mater must—for a given cycle of the thoracic pump—reach its maximal amplitude when the mean

<sup>1</sup> Here it is as was shown by Weed and Hufschon, there can be no pressure reduction of pressure within the membrane below the level of atmospheric pressure.

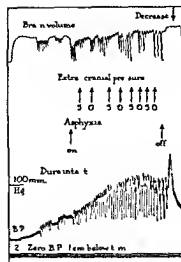


Fig 8 This tracing demonstrates the effect on brain flap of exerting an external pressure on the dura. The application of a pressure of 5 centimeters of water to the dura immediately reduced the amplitude of the excursions by about one half, with a prompt return to their previous size on releasing the pressure.

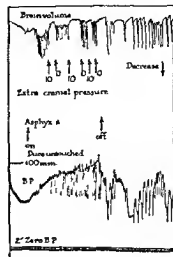


Fig 9 This tracing was prepared from the same animal as Figure 8 with the dura still intact. It shows that with double the pressure—10 centimeters of water—the movements of brain flap are virtually abolished.

intracranial pressure and the pressure of the atmosphere are precisely equal.

The experimental results described above bear out in unmistakable fashion the conclusions reached on theoretical grounds. In one group of experiments a reduction of intracranial pressure is followed by the appearance of brain-flap, and in another, the condition is abolished by increasing that pressure. In the third group, sudden reduction of a continuous pressure applied externally is associated with the immediate appearance of brain-flap.

The first group of experiments comprises those concerned with a reduction of the intracranial pressure, and the first method we adopted to effect this was the removal of blood from the animal. It was shown by Dixon and Halliburton, and confirmed by Becht, that hemorrhage produces a prompt reduction of the intracranial pressure. The latter worker also showed that, on the return of the withdrawn blood to the circulation, the intracranial pressure immediately recovered its former level. On the grounds of these experiments, he attributed the reduction and subsequent restoration of that pressure to purely mechanical causes, and there seems to be no reason whatever for disputing his conclusions.

Reference to Figure 2 will show our experimental findings. In this case, occlusion of the tracheal cannula in the earlier part of the ex-

periment produced no signs of brain-flap, in spite of vigorous respiratory efforts. Within a few moments after the withdrawal of blood, interference with the air entry to the lungs produced the condition. A further removal of blood, performed while the tracheal cannula was closed, was again associated with movements of brain-flap, which became progressively larger as the blood was withdrawn. Since it is accepted that hemorrhage lowers the intracranial pressure, by far the easiest explanation of these experimental findings is that the appearance of brain-flap is here conditioned by two factors: (1) the alternate aspiration and delay of blood from the brain, produced by strong respiratory movements against an artificial resistance to the air entry, and (2) the presence of a lowered intracranial pressure.

The results obtained after the intravenous injection of strongly hypertonic solutions entirely support the conclusions arrived at above. In Figure 4 is shown a continuous tracing, typical of those obtained by the injection of 30 per cent sodium chloride. Before the injection was started, the animal showed no signs of brain-flap on occlusion of the tracheal cannula. Within a few seconds of the termination of the injection, resistance to air entry was associated with brain-flap. As time went on, further occlusion of the tracheal

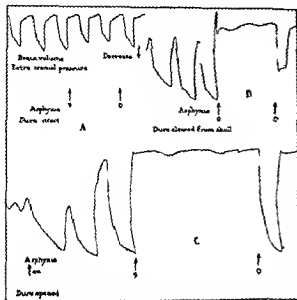


Fig 10. This is a composite tracing (The blood pressure curve has been omitted to economize space). There are three portions all prepared from one animal. A water pressure of 9 centimeters was applied. In A with the dura intact only a small diminution of the movements occurs. In B with the dura freed from the skull there is an apparent increase in brain volume and an almost complete arrest of the excursions. In C with the dura freed and opened there is a greater apparent increase in the brain volume with an equally complete abolition of the excursions. In all there is an immediate restoration of the size of the excursions on releasing the pressure. (The apparent increase in brain volume is produced by the bulging of the brain at the trephine hole opposite to that where the brain is compressed.)

cannula produced progressively larger movements of the brain volume lever. This may be seen in Figure 5, a tracing taken from the same animal that was used for Figure 4. In the latter part of the tracing will be seen small movements of the lever, occurring when there was no resistance to breathing. These small movements are due to relatively small fluctuations of the intrathoracic pressure, caused by vigorous hyperpneic respirations which follow the period of asphyxia.

To Weed and McKibben is due the credit for the observation that intravenous injection of strongly hypertonic solutions is followed by a reduction of the intracranial pressure. Their work has since been confirmed and expanded by many others (2, 4, 7). They attributed, and doubtless correctly, the fall of pressure to a depletion of the cerebrospinal fluid by the

greatly increased osmotic pressure of the blood. They found, further, that intracranial pressure, after a brief rise, went on falling, until, in the animal with an intact skull, this pressure might be well below that of the atmosphere. In a later paper Weed and Hughson point out that such a reduction of the pressure below atmospheric level cannot occur in the animal with the skull opened.

Our experiments show that brain flap makes its appearance very shortly after the commencement of the injection, at a time when, as found by Weed and McKibben, the intracranial pressure has begun to fall. Further, we find that the movements become progressively greater with the lapse of time. This close parallelism between the time relations, on the one hand, of the appearance and the amplitude of brain flap, and, on the other, of the changes in the intracranial pressure, can be clearly explained by the dependence of brain flap on these changes. It is interesting to observe that when intracranial pressure has been greatly lowered even the slight degree of acceleration and delay of venous outflow from the brain that occurs during pure hyperpnea—with no resistance to breathing—is sufficient to cause small but unmistakable variations in the brain volume. This bears out the theoretical view of brain flap, which commences this section, and necessitates a modification of our former conclusions, which we shall stress at the close of the discussion.

We come now to the consideration of the second group of experiments, in which, by two different methods, there was produced an increase of intracranial pressure. The first of these methods we again owe to the work of Weed and McKibben, who showed that the intravenous injection of strongly hypotonic solutions such as distilled water, produced a rise in this pressure. The increase of intracranial pressure is, they believe, due to a change in the osmotic pressure of the blood, opposite, of course, in sign to that produced by hypertonic solutions. Their work has been confirmed frequently and their explanation remains unchallenged.

Figure 6 depicts most clearly the result of the intravenous injection of distilled water into an animal which had been so affected by

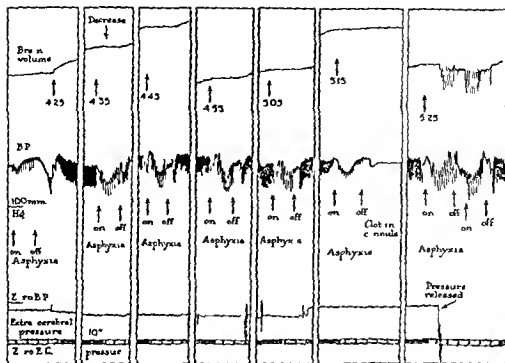


Fig 11 This is a composite tracing made up of small portions of a continuous tracing prepared in an experiment, in which a high pressure was maintained on the dura for an hour. At first, before the pressure was applied, no brain flap resulted from "asphyxia." At 4 25 p m the pressure was applied and maintained for an hour and during this period "asphyxia" was induced at 10 minute intervals without eliciting any trace of brain flap. The pressure varied from 30 to 40 millimeters of mercury during the experiment. There is a steady rise in the level of the brain volume lever, artificially interrupted at intervals. This rise was due to a slow leak of blood from the skull into the cavity of the brass instrument. At 5 25 p m "asphyxia" was once more induced without eliciting brain flap. During the maintenance of the "asphyxia," the pressure was suddenly released and brain flap instantaneously appeared. Later, the movements became less, and finally disappeared after about half an hour. This is not shown in the tracing.

hemorrhage as to show well marked brain-flap. The water was injected discontinuously in amounts of 50 cubic centimeters at a time. The immediate result of the administration of 200 cubic centimeters was a reduction of the amplitude of brain-flap. A further 500 cubic centimeters was then injected, the animal being tested for brain-flap at intervals. Very shortly after the commencement of this second injection, the condition failed to reappear and was not seen again during the remainder of the experiment. The cessation of brain-flap so closely follows the injection of water that it is difficult to escape the conclusion that disappearance of the movement is directly due to the rise of intracranial pressure induced by that injection. The tracing represented in Figure 7 completely supports this view.

The second method employed in the investigation of this part of the problem was the

application of a definite but small pressure to the intact dura mater, the contents of which may, for our purposes, be considered as a fluid which will transmit pressure equally in all directions. The experimental difficulties met with have been explained and need not be further discussed.

In Figures 8 and 9 are shown two tracings prepared from the same animal, in which brain-flap had been induced by hemorrhage. In the former will be seen the results of applying a pressure of 5 centimeters of water to the dura mater and in the latter the effects of a similar application of 10 centimeters of water pressure. With 5 centimeters there is an increase in the apparent volume of the brain and a marked diminution in the excursions of the brain volume lever. With 10 centimeters there is a similar apparent increase in the brain volume, but the movements of the lever



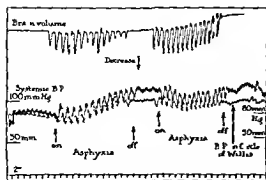


Fig. 12 This tracing displays the effect of eliciting brain flap on the blood pressure in the circle of Willis. It is easily seen that the variations reproduce in miniature those occurring in the femoral artery. They are dependent therefore on 'asphyxia' rather than on brain flap.

cease almost completely. In each case, reduction of the external pressure to atmospheric level is followed by complete restoration of the amplitude of the excursions. These experiments, we think, are absolutely conclusive. There can be no doubt that the increase of intracranial pressure produced by the application of external pressure to the dura led in the one case, to a reduction and in the other—with double the pressure—to a virtual abolition of brain flap.

Our third group of experiments, represented in Figure 11, must now be considered. It was thought that the application of a considerable degree of pressure to the dura mater would in time drive a certain amount of cerebrospinal fluid—together with venous blood—out of the skull by way of the veins. Fluid would also pass directly to the spinal subarachnoid space through the foramen magnum. This depletion would reduce the volume of the cranial contents and when the external pressure was removed intracranial pressure would fall. To test the relation of this fall to the appearance of brain flap we chose an external pressure of from 30 to 40 millimeters of mercury which could be applied to the dura mater without causing any appreciable change in blood pressure. The tracheal cannula was occluded before the experiment and at intervals of 10 minutes throughout its duration without eliciting cerebral movements. Finally, after the application of pressure had continued for an hour, the cannula was again closed, and while

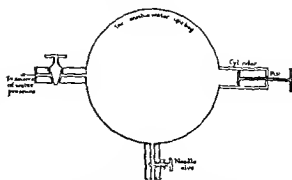


Fig. 13 This is a diagram prepared to simplify the appreciation of the theoretical part of the discussion. It requires no further description than appears in the text.

the animal was making vigorous inspiratory efforts the pressure was suddenly removed. There was then, as we anticipated, an absolutely instantaneous appearance of brain flap.

It remains now to consider how far the clinical evidence supports the experimental. In the case described in the present paper, the cerebrospinal fluid was drained off by a needle from the ventricles. The flow was rapid at first but later became slow. This slowing can be attributed only to a reduction of the intracranial pressure toward atmospheric level. Brain flap here was exceedingly well marked. There was no external interference with the respiration but the continuous conversation of the patient must have placed some obstruction in the path of a free air entry.

In the three cases reported in our former paper, in which a prolonged period of brain flap was present there was in each a draining off of the cerebrospinal fluid. In Wheeler's case there was a fracture of the base of the skull and the cerebrospinal fluid was seen escaping through the nose. In McConnell's case, a hydrocephalus was tapped. In our own case, the lateral ventricle had been drained.

These four clinical cases—the only ones in which a prolonged period of brain flap has been observed—resemble our experimental cases in which the intracranial pressure had been greatly reduced.

In the discussion of our experimental cases we have sought to prove, and in our opinion have proved, that, for the appearance of brain flap a reduced intracranial pressure is necessary. When these clinical cases are taken into

consideration, it is obvious that they clinch our deductions

The other clinical cases, in which a short period only of brain-flap was observed, may be correlated with the experiments in which a high external pressure was applied to the dura mater for some time and then suddenly released. In each of the clinical cases, a piece of bone which depressed the dura mater was removed, and, as soon as the membrane was relieved of this external pressure, a few large movements of brain-flap were observed, which died away rapidly. In our experimental work a high pressure—30 to 40 millimeters of mercury—was applied to the dura mater and left to act for an hour. Synchronously with the sudden removal of this pressure during a period of dyspnoea, brain flap at once began. The condition was not permanent, and, after about half an hour, could no longer be demonstrated. We have no means of estimating what degree of pressure was being exerted by the depressed bone in the cases of fracture, but, judging by the similarity of effect, it would seem that the causation of the brain-flap, both in the clinical cases and under experimental conditions, was precisely similar since in each category the first appearance of cerebral movement exactly synchronized with the relief of pressure, and, in each, the movement was transient.

Finally, it will be necessary to modify one deduction made in our previous paper. We have observed in our further experiments that brain-flap may occur during a period of hyperpnoea when there is no abnormal resistance to respiration. We think, therefore, that we laid too much stress on the need for this abnormal resistance as a factor in the causation of brain-flap. On the other hand we are most firmly convinced that brain-flap is conditioned by variations of intrathoracic pressure. It is clear, too, from the analogy of the bag, that—given a sufficiently low intracranial pressure—even a small aspiration by the thorax of venous blood from the brain will produce a definite, though small, diminution in brain volume

#### SUMMARY

1 A further study is presented of the large respiratory excursions of the exposed brain

(and dura) which the authors have termed "brain-flap"

2 A case of prolonged brain-flap in man, associated with great reduction of intracranial pressure, is described

3 A series of experiments designed to show the relationship between brain-flap and the intracranial pressure, is described and discussed

4 It is proved (a) that brain-flap is inhibited by factors which raise intracranial pressure, (b) that it is directly associated with factors which lower intracranial pressure

5 It would appear from clinical and experimental observations that brain-flap does *not* occur when the intracranial pressure is normal

6 The appearance and disappearance of brain-flap is explained on simple physical grounds, thus—

7 The wall of a membranous bag which is already tense with fluid contained under a pressure greater than that of the atmosphere will not show obvious oscillation if *small* additions to the fluid contents alternate with *small* subtractions. Oscillations of the membranous wall due to these small additions and subtractions become obvious only when the mean pressure within the bag approaches the external pressure

The membrane will be most sensitive to change of pressure, and its movements will be maximal, when the mean pressure on its inner face is equal to that which the atmosphere exerts on its outer surface

8 Brain-flap thus appears if, and only if, the mean intracranial pressure approximates to that of the atmosphere. Then (a) the exposed dura mater (or brain) is pushed inward by the atmosphere whenever the fall of intrathoracic pressure, which accompanies inspiration, withdraws enough venous blood from the skull to bring the pressure of its contents, for a moment, below the level of atmospheric pressure. (b) The sunken dura mater is pushed outward when expiration—by raising the intrathoracic pressure—checks the venous outflow from the skull so that intracranial pressure begins to rise

9 The excursions of the exposed brain (or dura mater) become maximal when the mean

intracranial pressure is equal to atmospheric pressure, in the same way that—during a clinical estimation of diastolic pressure—the arterial wall moves most with each heart beat whenever the mean pressure within the artery is balanced by the pneumatic cuff

10 Further experimental work has shown that hyperpnœa, in the absence of respiratory obstruction, is sufficient to induce some degree of brain flap, provided always that the intracranial pressure is sufficiently low

11 During a period of brain flap, the changes in blood pressure in the circle of Willis do not differ from those which occur at the same time in other parts of the systemic circulation; they are an exact reproduction in miniature

of the pressure changes in the femoral artery, and, like them, are asphyxial in origin

The authors desire to place on record an expression of their gratitude to Dr K. Saman M Sc, Ph D (Manchester) for his most kind assistance in the performance of these experiments

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## CHANGES IN THE SPINAL FLUID FOLLOWING INJECTION FOR SPINAL ANÆSTHESIA

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**S**PINAL anæsthesia produces less toxæmia and almost negligible protoplasmic disturbance as compared with general anæsthesia because of the supposed non toxic action and small amount of the medicament used. However there are certain immediate and remote sequelæ to spinal anæsthesia which as yet have not been satisfactorily explained. Munchmeyer states that in 1,189 cases of spinal anæsthesia with stovaine, not more than 70 per cent were entirely free from by effects or after effects. One patient in his series died from respiratory failure and seven suffered transient paralysis. Schultz reports a series of 2,251 cases operated on by means of ipocathes spinal anæsthesia. In no case was there a mortality attributed to the effects of the anæsthesia. However, vomiting or retching occurred in practically every case and other sequelæ such as incontinence of urine and feces, headache, and paresthesias of the leg were common, all of which disappeared spontaneously. Three patients complained of pain along the course of the sciatic nerve from 1 to 4 weeks after the operation. Madden reports 3 fatalities following the use of stovaine

spinal anæsthesia in doses of from 40 to 60 milligrams. Failure of respiration was given as the cause of death. Heinke and Laeven have observed severe circulatory disturbances with weak pulse and pallor in 2 cases following novocain spinal anæsthesia in doses of 15 milligrams. Gabbett reports one fatality following a slight operation under spinal anæsthesia in which he used 100 milligrams of novocain and 1 milligram of strychnine. In this case death also resulted from respiratory failure. Hatcher and Eggleston, in discussing the toxic action of novocain, state that they have been informed of two deaths resulting from novocain spinal anæsthesia. In one case the patient rolled off the table in the state of opisthotonos and died of failure of respiration. Beraud reports a fatality in a male 60 years of age, apparently in excellent physical condition before operation after stovaine spinal anæsthesia. Death in this case was attributed to cardiovascular embarrassment.

Le Poutre cites a case of urinary incontinence with perineal anæsthesia in a young man of 23 after spinal anæsthesia and suggests that the irritating action of the medicament

employed and the degree of concentration may be important factors in the sequelæ following spinal anesthesia.

Smith and Porter studied the effect of the spinal anesthesia on the blood pressure in cats and found that in only 1 of their series of 20 was there a marked fall in blood pressure, which they attribute to paralysis of the bulbar vasomotor center. They also found that a greater fall of blood pressure occurred in cases in which adrenalin was used in connection with novocain. Gray and Parsons studied the blood pressure in man during spinal anesthesia and found a slight fall which they claim was due to relaxation of the muscles of the abdomen and lower limbs, the greatest fall in blood pressure obtained in some cases was attributed to paralysis of the intercostal muscles and the consequent diminution in the pumping action of the chest.

Much has been written regarding the chemistry and cytology of the cerebrospinal fluid in morbid conditions where changes from the normal may be expected. It was thought that if some of the sequelæ of spinal anesthesia were due to toxic and irritating actions of the medicament employed, changes in the spinal fluid would result. With this in mind the following investigation was undertaken.

A review of the available literature reveals the fact that some work of this kind has been done mainly by French investigators. Revault and Aubourg in 1901 showed an increase in cytology in the spinal fluid following the use of spinal anesthesia with cocaine, which they interpreted as a meningeal reaction to the drug used. Quinard reported like findings, that is, a pleocytosis with the production of a fibrinous coagulate following cocaine spinal anesthesia. Barker examined the spinal fluid 46 hours after spinal anesthesia with stovaine and found a definite increase in the cytology, which consisted of "leucocytes of various forms." The extent of the pleocytosis and the number of cases examined is not stated. Sicard and Salin in 1910 showed a marked increase in cytology in the spinal fluid following the injection of horse serum, Ringer's solution, and sodium chloride respectively in animals. Mestrezat and Riche in 1911 studied 10 cases 6 to 12 hours after spinal anesthesia with

stovaine and reported a slight increase in sugar and chlorides, slight pleocytosis without an increase in the albumin content of the spinal fluid. They conclude that spinal anesthesia with stovaine is harmless as far as the nerve centers are concerned. Krey studied the spinal fluids of 8 cases, 3 of which were after the injection of 5 per cent tropocain in saline. The others were after the injection of phenolsulphonephthalein and neosalvarsan. In the first few hours after injection of these drugs, there was a slight pleocytosis, mainly of lymphocytes, together with a slight increase in albumin. He makes no distinction between the findings with tropocaine and those with the other agents employed. More recent work by Mader shows that after the injection of Ringer's solution, there is a rapid increase in sugar and lymphocytes in the spinal fluid, with a gradual return to normal.

Leclerc made observations on the spinal fluid in 31 cases of spinal anesthesia in which 5 per cent allocain (Lumière) without adrenalin was employed. Punctures were made from the day following the anesthesia up to the eighth day. In 9 of 31 cases there was observed a pleocytosis of about 15 to 21 cells per field, the cells all being lymphocytes. In one case there was a polynuclear increase in the cells. Increase in the albumin content of the spinal fluid occurred in 11 of 31 cases. However, the most constant finding in the spinal fluid was an increase in the sugar which occurred in 21 cases. In attempting to correlate the clinical symptoms and changes in the spinal fluid observed, Leclerc was not able to find any relationship between the increase in cytology and the occurrence of cephalalgia. In his series there were 2 such cases which did not show any increase in the number of cells over the normal. However, there were 6 cases with manifestations of mild meningitis (headache, vomiting, backache, sometimes rigidity of the neck). In these, pleocytosis occurred in 4 cases of 8, 15, 15, and 21 lymphocytes per field respectively. However, he was not able to correlate the other findings, such as increase in albumin and sugar, with the occurrence of post spinal anesthesia sequelæ.

In this investigation, spinal fluids were obtained in the usual manner employed in the

TABLE I—SPINAL FLUID CELL COUNT BEFORE SPINAL ANESTHESIA AND TWELVE HOURS AFTER OPERATION

Cell count per cubic millimeter spinal fluid		
Case	Before	After
1	5 lymphocytes	60 lymphocytes
4	10 lymphocytes	25 lymphocytes
6	0	70 lymphocytes
8	3 lymphocytes	12 lymphocytes
9	3 lymphocytes	5 lymphocytes
10	5 lymphocytes	800 poly morphonuclears
11	0	200 lymphocytes
12	4 lymphocytes	12 lymphocytes
16	3 lymphocytes	150 lymphocytes
17	0	20 lymphocytes
19	5 lymphocytes	60 lymphocytes
20	5 lymphocytes	240 lymphocytes
21	0	50 per cent polymorphonuclears
22	0	10 per cent lymphocytes
30	3 lymphocytes	150 lymphocytes
Average	3.43	150.2

Cases manifesting postoperative spinal anesthesia sequelae (Table III)

operating room just before the introduction of novocain into the canal. Part of the fluid was used as solvent for the anesthetic and re-injected into the spinal canal. The remainder was sent to the laboratory and examined immediately. Twelve hours after operation lumbar puncture was again performed and an examination of the fluid made. The following tests were employed:

1. Cell count and differential white count
2. Chemistry, which included the nitric acid ring test for albumin, the Noguchi test for globulin, and Fehling's test for reducing substances
3. Colloidal gold reaction
4. Quantitative determination of sugar by the Folin Wu method

These tests were done immediately after withdrawal on all spinal fluids. The patients were observed closely for the development of any neurological phenomena. A careful record of the occurrence of any untoward symptoms such as headache, etc., was also kept.

Thirty-one cases were studied in this manner. Of these, there were 14 in which the spinal fluid did not contain any red blood cells. Those fluids in which the presence of red blood cells was considered as due to trauma incidental to the lumbar puncture were not included in Table I. Of these 14 cases, 11 showed a definite increase in the white blood cell content, the highest being 800 per cubic millimeter, all of which on smear proved to be

TABLE II—SPINAL FLUID SUGAR DETERMINATIONS BEFORE SPINAL ANESTHESIA AND TWELVE HOURS AFTER OPERATION

Case	Reducing substance Mgm per 100 ccm		Difference mgms	Per cent increase
	Before	After		
1	65.0	85.0	20.0	20.4
2	38.0	115.0	77.0	20.0
3	100.0	125.0	25.0	25.0
4	70.0	85.0	15.0	21.9
5	81.0	103.0	22.0	23.0
6	74.0	81.0	7.0	7.6
7	82.0	115.0	33.0	41.6
8	65.0	85.0	20.0	25.0
9	87.0	111.0	24.0	27.5
10	64.0	80.0	16.0	27.0
11	86.0	131.0	45.0	51.0
12	61.5	78.0	16.5	24.8
13	60.0	80.0	20.0	20.0
14	115.0	160.0	45.0	31.7
15	85.0	105.0	20.0	20.0
16	71.0	100.0	29.0	40.8
17	73.0	85.0	12.0	8.9
19	61.0	105.0	44.0	60.3
21	1.0	70.0	69.0	7.0
22	85.0	125.0	40.0	47.1
Average	4.55	101.05	21.2	37.3

Cases manifesting postoperative spinal anesthesia sequelae

polymorphonuclear leucocytes. Four cases showed counts of 240, 250, 200 and 200 cells, on smear the first three being all lymphocytes, the fourth case showing 50 per cent polymorphonuclear cells and 50 per cent lymphocytes. Six cases showed counts varying from 20 to 150 cells, all lymphocytes.

The remaining 3 counts were 5, 12, and 12 cells respectively, which here are not considered as a definite increase in the cytology. Thus of the 14 cases, there were 11 showing a very definite pleocytosis, 2 a slight pleocytosis, and 1 a normal count (see Table II).

A study of the chemistry, i.e., the albumin and globulin content revealed no departure from the normal. The albumin was not increased and in no case was the globulin reaction positive. This would indicate that the protein content of the spinal fluid was not altered at least qualitatively. This was confirmed by the colloidal gold reaction, since in no case was there any reduction of the colloidal gold.

In 20 of the 31 cases, the quantitative determination of sugar was done before the 12 hours after the injection of novocain. In all 20 cases there was an increase in the sugar content, in the postoperative specimens varying from 7 to 135.2 per cent. In but 3 cases (6, 19, 21) could the increase be considered

TABLE III—POSTOPERATIVE SPINAL ANÆSTHESIA SHOWN BY SPINAL FLUID FINDINGS

Case	Symptoms	Spinal fluid			
		Cell count		Sugar—mgm	
		Before	After	Before	After
8	Vomited three times 24 hours postoperative	3 w b c Lymph	12 w b c	69	85
11	Nausea first 24 hours postoperative	3 w b c Lymph	800 r b c 100 w b c Lymph	62.5	78
14	Vomiting at end of operation	4 w b c Lymph	12 w b c Lymph		120
15	Vomiting first 24 hours postoperative	3 w b c Lymph	70 r b c 50 w b c Lymph	68	160
16	Retching during operation Vomited twice first 24 hours postoperative	3 w b c Lymph	250 w b c Lymph	83	105
19	Severe headache first 24 hours postoperative	5 w b c Lymph	90 w b c Lymph	75	83
20	Severe retching during operation Vomiting during first 24 hours postoperative	5 w b c Lymph	240 w b c Lymph	62	105
23	Vomiting during first 24 hours postoperative	5 w b c Lymph	140 r b c 100 w b c	65	115
24	Pain in right leg 3 days postoperative—duration 4 days Inability to void first 24 hours postoperative	many r b c	many r b c		85
28	Vomiting headache dizziness backache pain in right leg	3 w b c Lymph	2100 r b c 20 w b c Lymph		150
29	Nausea and vomiting during operation and 24 hours postoperative	3 w b c Lymph	10 r b c 30 w b c Lymph		
30	Vomiting and headache first 24 hours postoperative	5 w b c Lymph	120 w b c Lymph		
31	Inability to void first 24 hours postoperative	3 w b c Lymph	many r b c		

within normal limits, being less than 10 per cent. In the 17 other cases there was a significant increase in sugar. The greatest increase occurred in case 15 where the content rose from 69 milligrams per 100 cubic centimeters of fluid before injection to 160 milligrams 18 hours after operation, a rise of 135.2 per cent. This estimation was repeated and confirmed. There was nothing unusual in this case to account for this rise, neither were there any unusual complaints or clinical findings present. The average rise calculated on the basis of percentage increase for each case was 37.3 per cent.

Of the 31 cases studied 13 developed mild postanesthesia sequelæ such as nausea, vomiting, retching, headache, backache, inability to void, and sciatica-like pains in the leg (Table III). A study of the spinal fluid in these cases reveals the fact that in 6 there was a definite increase in the cytology of the spinal

fluid viz. 12, 12, 250, 90, 240, and 120 cells, all of the lymphocytic variety. The 7 other cases showed red blood cells in the spinal fluid which as stated above were attributed to the trauma incident to the tap.

However, those 7 cases which showed a definite pleocytosis (60, 25, 70, 800, 200, 20, 200 cells) after the spinal anesthesia did not manifest any postspinal anesthesia sequelæ whatsoever (see Table I).

The spinal fluid sugar in 10 of the 13 cases showing postanesthesia sequelæ were definitely increased. In the 3 other cases determinations were not made. However, there were 16 cases which also showed very definite rises in the spinal fluid after the spinal anesthesia, which did not present any sequelæ. There seems, therefore, to be no correlation between the occurrence of sequelæ after the spinal anesthesia and the changes in the spinal fluid recorded above.

## SUMMARY

1 The spinal fluids of 31 cases were examined 18 hours after spinal anesthesia

2 Of 14 cases 11 showed a definite pleocytosis, 10 cases being of the lymphocytic variety, 1 of the polymorphonuclear variety. Seventeen cases were not considered because of the presence of red blood cells in the spinal fluid

3 In 20 of the 31 cases examined, there was an increase in the spinal fluid sugar averaging 37.3 per cent

4 There was no change in the albumin, globulin, or colloidal gold curves

5 Thirteen of the 31 cases developed mild postanesthesia sequelæ

6 There was no correlation between the occurrence of postanesthesia sequelæ and the changes observed in the spinal fluid

7 The technique of spinal anesthesia caused in certain instances a mild meningeal reaction, but apparently does not produce serious organic changes, as reflected in the change of the composition of the cerebrospinal fluid

## CONCLUSIONS

Just what the cause of the increase in cytology and sugar in the spinal fluid after spinal anesthesia is, we cannot say. The pleocytosis would seem to indicate a certain amount of irritation of the serous lining of the subarachnoid space, but whether it was due to a general irritation of the whole extent of the dura or only of the immediate neighborhood of the puncture it is impossible to say from these observations on the human subject. The

increase in sugar together with the increase in lymphocytes in the spinal fluid might be interpreted in the nature of a mild encephalitis (since spinal fluid findings in the latter condition are quite the same as those recorded above). However, the absence of sequelæ in more than half of the cases studied, as well as the rapid disappearance and the mild character of the symptoms present after spinal anesthesia would argue against this.

Further studies are being made in which simultaneous blood and spinal fluid sugar determinations are being done, before and after novocain injection, in order to observe if any relationship exists between the sugar content of the blood and spinal fluid under these conditions.

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# CLINICAL SURGERY

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## MIRAULT OPERATION FOR SINGLE HARELIP

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**E**ACH year in the United States approximately one thousand children are born with more or less complete patency of the lower part of the primitive frontomaxillary fissure. In the great majority of these children sufficient tissue is present, if properly used, to permit of an acceptable surgical repair. At least this is true of the defects of the lip and nose.

Because the lip defects are apparently simple clefts and because much of the dicta on their repair has inclined toward triteness, many surgeons have fallen into the gross error of thinking that the repair is easy, hardly worthy of special effort. Yet, in spite of these facts, in few other surgical situations are evident possibilities and average accomplishment so far apart.

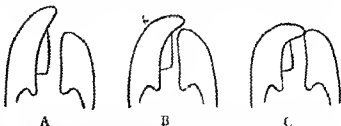
The correction of such defects is more or less simple, but it is a simplicity that is attained only by grinding effort. Though these open clefts differ much in appearance in various cases, their individual differences are more of degree than of kind, so that any one of several operative plans can be made applicable to the ordinary case. If he learns to use any one of the standard methods, the surgeon who assays the correction of nose and lip defects will expend his energy to greater profit than if he attempts to exercise eclecticism, or more dangerous yet, to contrive new methods. It is true that operative skill rather than breadth of acquaintance will bring greater satisfaction to the patient thus afflicted. This statement is made with no intention of belittling invention or ingenuity but rather to urge that these qualifications be directed, in the case in hand, toward adapting some well tried out plan. As a rule the simple plans are easier to execute but they are less plastic. Every added complexity of technique is a distraction and is justified only by commensurate added possibilities. Before adopting the more complex methods, therefore, the operator should make himself familiar with every detail of the operation and should understand the logic for doing it. As the operator acquires more skill he may feel jus-

tified in adopting a method that in earlier days he considered less feasible, but each modification will be like changing a golf stroke—not always free from immediate grief.

After the surgeon has gained the greatest possible surgical and mechanical skill with the most congenial method, he may still find that the results are not really pleasing unless his technique includes also artistry, which here, as in portraiture, can camouflage a multitude of defects.

In the repair of the lip, an open alveolar cleft is one of the great "bugbears" but we believe this need not be so.

Plans for forcefully approximating the separated halves of the hard palate were discussed and dismissed as unnecessary in the first quarter of the nineteenth century, to be revived in the third, and to be popularized in the fourth quarter, until now the operation has come to be regarded by many as indispensable in the treatment of wide open clefts. A number of surgeons now secure a uniformly high average quality of repair of lips and palates following preliminary forceful closure of the alveolar cleft. Our own observation and experience, however, have convinced us that



**Fig 1.** Replacement of the premaxilla. A. Diagram of an open, complete single cleft. B. Shows desired relationship of the premaxilla to the maxilla in the closure of the alveolar cleft. This gives the greatest prominence to the upper lip and least width to the anterior part of the palate cleft. Such a relationship usually follows within 3 to 15 months after a simple repair of the lip over the open alveolar cleft. C. Shows an improper adjustment of the premaxilla to the maxilla, resulting from misdirected force. It causes retraction of the upper lip and an increased width in the anterior part of the cleft palate. See also Figures 6, 7, and 8.





Fig 2 Shows the closure of the alveolar part of the cleft that will usually occur when the lip is repaired. A is a cast made of a cleft palate in a child 20 weeks old. At this age it is not good practice forcefully to close the alveolar part of the cleft but the lip is repaired. The other three casts were made at 23, 30 and 44 weeks respectively and show the gradual closure which occurred from the lip pressure without any damage to the developing teeth. This closure by lip pressure will occur usually regardless of the width of the cleft.



Fig 3 Cast of a child whose lip has been repaired over an open alveolar cleft at 2 weeks of age, yet 23 months later it will be seen that there was a wide alveolar cleft. In the few cases we have observed in which the alveolar cleft failed to close in a reasonable time from lip pressure approximation in this part has rapidly followed the flap operation on the palate but in young infants it is not practical to unite the flap edges along the anterior third of the bony cleft if there is a wide alveolar separation. This does not always necessitate an extra operative sitting because this part of the palate can be closed later at the same time as the opening in front of the alveolar process is closed.



Fig 4 Maxillary wiring growth distortion. A Den-  
tures of an 11 year old child in whom a complete left sided  
cleft was closed by transfixing wires at the age of 2 days.  
Note the lack of forward progression of the maxilla and  
that the teeth of the lower jaw are inclined lingually. B  
Shows the condition at 17 years of age after 6 years of al-  
most continuous treatment by an experienced orthodontist.  
This is a better orthodontic restoration than has been ob-  
tainable in a number of such extreme deformities that have  
come under our observation. Though such deformities are  
the exception rather than the rule, their possible occurrence  
should we believe, taboo the practice of transfixing the in-  
fantile maxilla with wires.



Fig 5 Maxillary wiring profile. Profile of Figure 4B  
showing flatness of the upper lip due to the lingual position  
of the upper incisor teeth despite the orthodontic treat-  
ment. This flatness has forced upon us the practice of re-  
placing these displaced anterior teeth with an artificial den-  
ture in order to give proper prominence to the upper lip.

1 Unless done with real skill and judgment, forceful closure of the alveolar cleft can add difficulty to rather than ease the subsequent mucopneostomal closure of the palate cleft (Fig 1).

2 Although the immediate results from the technique described by Brophy may be good, bad deformity of the upper jaw may subsequently develop (Figs 4 and 5). In some instances such deformities can be corrected to some extent by years of orthodontic work but in others they can only be compensated for by most exacting surgical and prosthetic procedures (Figs 6, 7, and 8).



Fig 6A



Fig 6B



Fig 6C

Fig 6 Maxillary wiring profile A, Shows profile of a girl who, following early bone wiring, had an extreme retraction of the maxilla

B, The dotted line shows the amount of correction that was obtained by a combination of orthodontia, the advancement of the cheeks, lip, and columella on their supporting structures, and the use of an artificial denture. All of this could have been avoided had the simpler plan of maxillary adjustment been used

C Shows final correction

Fig 7 Normal prominence of the upper lip A Profile of an average infant of 2 months of age. Note how far the upper lip protrudes beyond the lip and chin B, Young infant with complete right sided cleft of the upper lip and palate, recently repaired over a wide open bony cleft with out any attempt immediately to replace the premaxilla thus retaining approximately the normal relationship of the upper lip to the lower lip and chin for this age



Fig 7A



Fig 7B

Fig 8 Normal prominence of the upper lip A, Shows the prominence of the mid portion of the lip in a 12 hour old baby with a complete left sided cleft of the lip and palate B Shows this prominence persisting 12 days after the repair of the lip over the open bony cleft C Note the amount of retraction of the upper lip that has occurred during 9 months' subsequent development. If, at the primary operation on a young infant, the upper lip is not given its natural prominence at this age, in subsequent growth the upper lip is apt to become very much retracted



Fig 8A



Fig 8B



Fig 8C



Fig 9 Maxillary wiring tooth destruction. Shows an average amount of retraction of the upper jaw following early forceful closure of the cleft by bone wiring but also note the loss of the teeth on the cleft side with probable destruction of the germs of the corresponding permanent teeth

3 The premature loss of the first, and subsequent derangement or a possible loss of second, teeth following the transfixing of the jaw may be the source of expense, disability, or even untimely death in the producing period of life (Fig 9)

4 Transfixing the jaw with wires is an unnecessary step and one that does not of itself accomplish the object for which it is advocated, namely the better ultimate adjustment of the lip and nose (Fig 10)

Though the illustrated records of the earlier operators are very meager, the descriptions they have left give us reason to believe that certain surgeons doing this work in the first part of the last century had developed great skill in the planning and cutting. The results must have been compromised, however, by the use of the "harelip pins" which were dictated by the lack of anæsthesia. We can today accomplish by proper undermining and careful suture of the soft parts

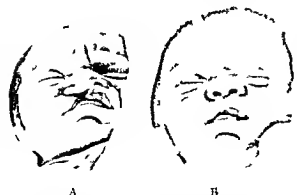


Fig 11 Repair of lip over open alveolar cleft. A Shows the characteristic external deformity of the soft parts in the presence of a complete single cleft of the lip and palate. B Shows the replacement that can be made over the wide open bony cleft. Note that the nostrils, columella and tip of the nose are approximately symmetrical to the midline of the face. See Figures 12, 13, 14 and 15



Fig 10 Maxillary wiring failure of accomplishment. A The midline of the premaxilla indicated by the line *M* has been brought past the midline of the face *C* in a complete left-sided cleft by a bone wiring operation done in early infancy. B Note that in spite of this overcorrection of the original maxillo-pre maxillary displacement the base of the columella of the nose remains drawn over to the right. This is just one demonstration of the fact that the distortion of the nose in a single one-sided cleft of the lip is but little dependent upon the interrelationship of the underlying bones. See also Figures 11, 12, and 13

every thing that is claimed for the direct bone adjustment, and, on the average, can do better work for lack of distraction of the attention from the essential points (Fig 11)

#### LATERAL DISPLACEMENT OF NOSE, SPREAD NOSTRIL

In a complete cleft of the lip and palate, the lateral deviation of the nose is, no doubt, due partly to the maxillary, and, with it the premaxillary, displacement, but uniformly there will be almost as much nasal displacement with a complete cleft of the lip and an intact alveolus (Fig 12)

The nasal deviation is due mostly to an actual change in the relation of the soft tissue and cartilages to the bone and comparatively little to the bony displacement (Fig 12). Therefore, it is not to be expected that shifting of the bone by itself will restore either the soft tissues or the cartilages to their proper position (Fig 10). On the other hand, with sufficient undermining, these soft tissues can be shifted far enough to compensate for both the soft tissue and the bony displacement, but this undermining must be almost as extensive on the non cleft side as on the cleft side (Figs 14 and 15). This is a story of "To have and also 'to hold," and unless certain adjustments are made and maintained, the nose will continue to deviate with subsequent growth.

To maintain the position of the bridge during the growing period, it is essential not only to bring the nose approximately to the midline but also to restore the normal relation of the labial end of the columella to the labial end of the alar. To accomplish this latter, the nostrils must be symmetrical, for the tip of the nose is composed of



Fig 12



Fig 13A



Fig 13B



Fig 14A

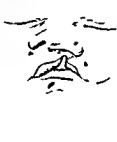


Fig 14C



Fig 14B



Fig 15A



Fig 15C



Fig 15B

Fig 12 Nasal displacement. This cleft of the lip over an intact alveolus shows the characteristic spreading of the nostril and the displacement of the nose and columella to the opposite side.

Fig 13 Nasal displacement. A Shows little more displacement of the nose in the presence of a wide open cleft than was shown in Figure 12, where the alveolus was intact. B, Shows repair of the lip and restoration of the nose to the midline without changing the relation of the sides of the bony cleft.

Fig 14 Unilateral undermining. A, Shows the displacement in a typical partial cleft of the lip with no bony cleft. Note that the transverse slit of the mouth is about symmetrical to the midline of the face but that the cartilaginous part of the nose has drifted somewhat to the right,

that is, away from the lip cleft. The dotted line in the cheek in the drawing indicates the extent of the undermining that was done in this case which was operated upon some years ago. B, In this picture, the immediate post operative result, it will be seen by the vertical lines that the mal relationship of the lower part of the nose to the mouth was not corrected by this operation.

Fig 15 Bilateral undermining. A, Shows a child with a complete right sided cleft of the lip and an open cleft in the alveolar process, with somewhat more nasal distortion than was present in Figure 14. The dotted lines in the drawing show the amount of undermining in this, a more recent case. In B it will be seen that with bilateral undermining of the soft tissues, the nose has been brought into proper relationship with the mouth and to the midline.



Fig 16A

Fig 16B

Fig 16C



Fig 17A

Fig 17B

Fig 17C



Fig 18A

Fig 18B

Fig 18C

Fig 16 Obliquity of the nose. These 3 young infants show the varying amounts of obliquity of the nose which in each is somewhat proportionate to the width of the cleft. See Figure 17.

Fig 17 Obliquity of the nose. Shows pictures of older children with about the same width of cleft as the 3 babies in Figure 16 and from this it will be seen that growth by itself in the presence of an uncorrected cleft has no tendency to correct the obliquity of the nose.

Fig 18 Obliquity of the nose. Shows a young baby with a fairly wide cleft and with typical obliquity of the nose which latter is almost completely corrected by the operation that closed the cleft. Figure B taken 12 days after operation. C Shows the condition a year later in which the new position of the nose has been well maintained. Note that in both B and C there is a slight droop of the inner end of the ala on the cleft side not corrected by the operation but this defect has no tendency to compromise the position of the nose as a whole.

the walls of the nostrils. Simply narrowing the transverse diameter of the floor of the vestibule without restoring its vertical height might, as far as we know, maintain the central position of the bridge but will not correct the lateral flatten

ing (Fig 22). These are very positive statements dealing with a very complex matter, but, over a long period of time, we have made a great many observations that lead us to believe that these statements are correct in the majority of cases.



Fig 19A

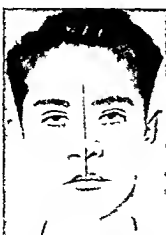


Fig 19B



Fig 21A



Fig 21B

Fig 19 A, Shows a 16 year old boy with a complete cleft of the lip and palate, which had not been operated upon. The pencil line shows the midline of the face from which it will be seen that the nasal deviation also involves the bony bridge. B, Shows the condition about 3 months later. Comparing the nose with the penciled midline in this picture, it will be seen that the position of the bony bridge was not corrected by the operation and that the stiffness of the deviated cartilaginous septum has prevented the base of the columella from being brought to a symmetrical position. From now on it is probable that with any further growth of the face these deviations will decrease rather than increase.

Fig 20 Obliquity of the nose. A, Shows a boy approximately the same age as the one shown in Figure 19, but on whom an average closure of the cleft had been done



Fig 20A

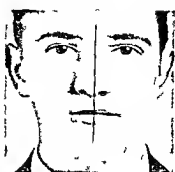


Fig 20B

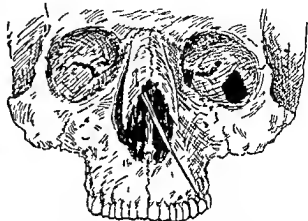


Fig 20C

in early infancy. As is very commonly the case, the proper relationship of the point of the ala to the base of the columella was not restored at this operation and, therefore, the deviation of the nose continued until it involved the bone as well as the soft parts. In this instance, the correction obtainable by readjusting the soft tissues would not have given complete satisfaction—therefore, the nasal bones and the lower end of the septum were mobilized and held in position by wires passed through the tissues and attached to the teeth. The drawing is taken from "Surgery and Diseases of the Mouth and Jaws," page 239. B Shows the final result in which the position of the nose, as can be seen in the photograph, is not quite symmetrical, but on the patient this is hardly discernible.

Fig 21 Obliquity of the nose. A Shows flattening of the nostril which ordinarily occurs in the single partial cleft of the lip. For some reason in repairing this case instead of rotating the nostril into proper relation with its fellow, an excess was removed from the floor which gave the small nostril shown in B.

Of one thing, however, we are even more sure there is no 100 per cent perfect about any of it (Figs 16, 17, 18, 19, and 20).

In a single cleft of the lip, the long axis of the nostril on the cleft side is more transverse than that of its fellow, the nostril as a whole is somewhat posterior to its fellow, and the nose is correspondingly flattened on that side (Figs 16 and 17).

To correct these nostril distortions, it is necessary, first, to mobilize all mal related structures with the least amount of external scar, second, to

draw them into the most natural form and position attainable, third, to fix them by suture, until healing has occurred.

#### TECHNIQUE OF OPERATION

Of a number of different plans that have been described for correcting the harelip, a few have gained wide acceptance. Each provides for the repair of an open cleft in the floor of the nostril but none that we know of goes far enough to give the best attainable nasal adjustment. This does not imply that our predecessors did not know

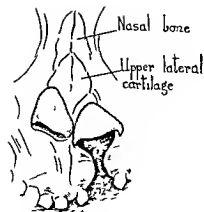


Fig 22A

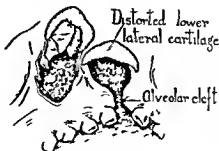


Fig 22B



Fig 24



Fig 23

**Fig 22 Nasal distortion.** These two figures are an attempt to semidiagrammatically illustrate the changes in shape and position of the lower lateral cartilage in a complete left sided cleft of the lip and palate. There is always some distortion of this cartilage in almost every lip cleft, it is greater in proportion to the extent and width of the cleft (see Figs 16 and 17) and becomes accentuated with growth in the uncorrected case. The outer surface of each cartilage is here shown in stipple the cleft in the bone and the nasal fossae are shown black. Note in A that the damaged cartilage has slumped caudally more so in its median than its outer part. In B the lateral spreading of the cartilage as it spans the cleft is more clearly shown. As the skin of the tip and ala is closely adherent to the cartilage that side of the tip and ala will be correspondingly flattened. No attempt to restore the contour of the nose will be successful that does not correct the distortion and displacement of this lower lateral cartilage.

how to do this, but we could find no description of a systematic plan recorded. We have, therefore, been led to work out certain definite plans for dealing with tissues surrounding the deformed nostril which might be used in connection with any one of the accepted plans of lip repair.

The first step is to mark off on the lip the plan of the external skin incisions. This will outline the raw surfaces to be united by sutures. Upon the accuracy of these cuts will depend the possibilities of the ultimate result. Therefore, while they are first planned and measured off with the eye, they are checked up with fine pointed dividers and pricked in with aqueous methylene blue solution on a fine "crow quill" pen or a hypodermic needle, before any cuts are made, so that the landmarks are not obscured by the under-

**Fig 23 Tissue mobilization.** The line of dashes indicate the mucous incisions through which the undermining is done that frees the cheek and lip tissues from the bone in a plane superficial to the periosteum. The heavy dotted line across the nose indicates an incision in the lining of the vestibule and through or above the lower lateral cartilage from which an undermining plane extends between the external skin and the lower lateral cartilage as far down as the reflexion at the free border of the ala. The coarse stippling indicates the extent of the undermining between the soft tissues and the bone. The fine stippling indicates the area of undermining between the outer surface of the lower lateral cartilage and the skin of the nose. The downward turn at the outer end of each fornix incision gives greater relaxation of the lip and is made just in front of the parotid duct opening. Along the fornix the incision is made far enough away from the bone so as to leave a sufficient full edge of mucosa to which to suture if desired.

**Fig 24 Thinning the spread ala.** The stippling indicates an area from which is removed subcutaneously a wedge of the excess tissue that occurs between the lining and covering in the outer part of the flattened ala. Above and internal to the lip cuts indicated by dashed line only the subcutaneous tissue needed to nourish the skin flap is retained. These steps greatly facilitate the subsequent molding of the nostril and the lip flap supplements the floor of the vestibule. (See Figure 56.)

mining and the accompanying flow of blood (Fig 37).

After the lip incisions are outlined, it is well again to identify the pertinent points in the nasal distortion with which we are about to deal (Compare with Figure 22 Figs 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 26, 27, 29, 30, 32, and 33, which show various types of nasal distortions).

The first operative step is the mobilization by undermining of each distorted or displaced tissue. This should release the restraining tissues from their underlying bony attachments, and at this stage cartilage may have to be shifted in its relation to bone, its fellows, or the overlying skin (Fig 23). If necessary, excision of excess tissue between the lining and covering of the flattened ala may be made at this time (Fig 24). The next



Fig 25



Fig 26A

Fig 26B



Fig 28A

Fig 28B



Fig 27A

Fig 27B

Fig 27C

Fig 25 Restoration of the floor of the nose. A Shows palate and labial fornix viewed from below with lip and cheeks cut away. The "cross hatched" area shows the line of the mucous incisions and undermining planes. B Shows the path of this suture viewed from below and the soft tissues being drawn forward from the bone. C, Indicates the course of the chromic gut suture viewed from in front. D, Shows the reposition of the tissues that results from the drawing up and fixation of this suture. This suture should not include any derma or it may cause some hesitancy in healing. The proper placing of this suture is essential to the proper molding of a distorted nostril.

Fig 26 Nasal obstruction. A, Shows a complete cleft in which the ala is drawn out into a flat hand, the lining wall being relatively the same length as the external skin covering. If this flat ala is tubed into a nostril, even after the lining is separated from the covering, the lower lateral cartilage and the skin lining will bend into and cause an obstruction in the nostril as shown in B. Packing the nostril with gauze and retaining the pack for some days after the operation will help correct this. Greater accuracy in distributing the lining is obtained by through and through mattress sutures (Fig 27B). Formerly, we incised the mucosa and lower lateral cartilage to lessen this deformity.

Fig 27 Nasal obstruction. A, Shows a baby with an alar distortion similar to that shown in Figure 26. Besides thorough undermining of the ala the proper relation of the lining to the covering was obtained by 2 or 3 mattress sutures tied on the external surface, B. Thus, in addition to the gauze packing gives a much more patent nostril.

Fig 28 Nasal distortion. The procedures illustrated in Figures 23, 24, 25, 26 and 27 will restore the floor of the nostril, base of the columella, and the floor of the ala in all infants and young children but in most cases after these maneuvers have been completed, there is a downward droop of the inner half of the affected nostril (see Fig 22A). In all but older children this can be corrected by removing a crescent of skin A from above this distorted part of the border and suturing the resulting defect as shown in B. Ordinarily, the excision goes down to, but not through, the underlying cartilage. If it has not already been done, this latter is thoroughly freed from the overlying skin by inserting a dissecting scissor into the opening before the defect is sutured. This suturing then draws the slumped cartilage up to its proper level. When indicated this crescent should be removed before the insertion of the mattress sutures shown in Figure 27, but the latter is necessary only if the outer half of the ala has been flattened out in a straight line.





Fig 29A

Fig 29B



Fig 30A

Fig 30B

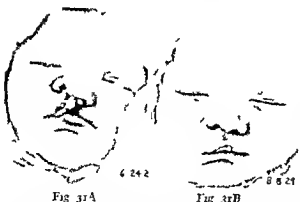


Fig 31A

Fig 31B

Fig 29 Nasal distortion. In young infants this crescentic removal may be necessary to correct a downward placement of the cartilage shown in Figure 22A but not the flattening shown in Figure 22B. In the case here shown the B deformity shows very plainly but if viewed directly from the point, it may be seen that the A deformity is not present, therefore it was not necessary to remove a crescent from above the inner half of the nostril in this infant.

Fig 30 Nasal distortion. In this infant with only a partial cleft the downward droop of the lower lateral cartilage shown in Figure 22A was quite pronounced, therefore a crescent was removed.

step in the actual operation is the making of at least the upper part of the incisions on either side of the cleft lip. For continuity of description, however, we will, for the present, assume that lip



Fig 32



Fig 33A

Fig 33B



Fig 33C

Fig 33D

Fig 31 Nasal distortion. In this infant there is quite a deep notch on the uncleft side at the junction of the nostril border with the columella as seen from the front. Therefore a crescent was taken out on the uncleft side to make the two symmetrical.

Fig 32 Nasal distortion. In older children and adults the manipulation and suturing shown in Figures 25 and 28 may not restore the proper relation of the 2 halves of the columella that is it will not correct the backward displacement of the inner half of the lower lateral cartilage (Fig 27B) and to do this it may be necessary to split the columella deeply through an external incision and substitute a triangular excision for the crescentic excision described in Figure 28.

Fig 33 Nasal distortion. Shows a 16 year old girl with pronounced cartilage distortion operated upon by the plan shown in Figure 32. Viewed from the front the border of the ala on the sound side presents a gentle concavity while on the cleft side it is of a very pronounced convexity. In this case there was very little real bony distortion of the nose and the whole nasal distortion was corrected by the operation on the soft tissues.

incisions have been made and proceed at once with the molding of the nostril.

The adjustment of the floor of the nose is made as shown in Figure 25, care being used to prevent



Fig 34A

Fig 34B



Fig 36



Fig 35

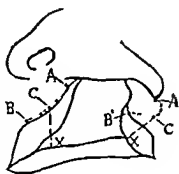


Fig 37

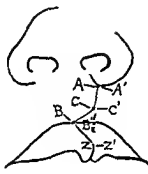


Fig 34 Suture scars In both these cases the greatest difficulty in the re-operation is the elimination of scars caused by badly placed sutures. In A the whole of the scarred area of the lip was excised which made an undesirable tightness from side to side. In B the two transverse scars were excised individually and the defects closed by fine skin sutures in the hope of making these less visible.

Fig 35 Suture scars Objectionable suture scars can be avoided by placing all stay sutures from the mucous surface and approximating the epithelium with fine sutures that engage not more than 1 millimeter on either side and are not pulled too tight. Horsehair is apt to make better scars than silk and the postoperative care of the wound may have something to do with the result.

Fig 36 Mirault operation Lip incision We have had some difficulty in making out just what was Mirault's original operation. This picture is in Henry Hollingsworth Smith's *Operative Surgery* (1892) and is labeled "Mirault's operation." It was upon this that the following operation was based, but the details as given in this paper were gradually worked out from our own experience. One might infer from studying the figures that the correction of the spread nostril was not part of the operation. (The usual nasal deformity is not shown.) Note also that the raw surface corresponding to  $A'C'$  in our Figure 37 is longer than the  $C'B$  surface. This will work out possibly more satisfactorily than our plan, in partial lip clefts, but for uniformity we use the plan shown in Figure 37 in almost all cases of primary operation.

The statement has been lately emphasized that using a displaced flap in the repair of a lip cleft would cause muscular distortions in the movements in the new lip, with this point in view, we have recently made a study, both directly or by means of movie films, of about 30 cases operated on by this plan and in none of them, after the immediate postoperative stiffness disappeared, were there any asymmetrical contortions evident.

Fig 37 Lip incision, Mirault operation The points  $A$ ,  $B$ , and  $C$ , and  $A'$ ,  $B'$ , and  $C'$  are the ones to be pricked in before the undermining.  $A$  is placed on the mucocutaneous

junction just above the point at which a line corresponding to the oblique base of the columella would intersect the vermillion. Usually in a complete cleft of the lip, there is a very slight shallow notch in the skin at this point,  $B$  is placed just where the ridge that bounds the philtrum on the opposite side meets the mucocutaneous junction,  $C$  is a point half way between  $A$  and  $B$ . While it was stated that the points  $A$ ,  $B$ , and  $C$  were placed in the mucocutaneous line in practice, they are put just within the skin border so that when the incisions are made, the marks will still be visible as guides in placing the sutures. In a partial cleft,  $A$  is located just on the inside of the defect of the lip instead of along the mucocutaneous junction which in this instance does not extend up this far.

On the outer side of the cleft,  $A'$  is put just beyond the point of the ala (see Figures 38 and 42). By drawing the lip downward and outward the exact point where the ala joins the lip will become visible. The placing of point  $C'$  requires some consideration. It should be under, and rather internal than external to  $A'$ , and at a vertical distance from the vermillion border equal to  $C'A$  (see Figures 43, 44, 45, 46 and 47).  $X$  is supposed to represent the future level of the vermillion border at this point,  $B'$  is on the mucocutaneous line at a distance from  $C'$  equal to  $BC$ . The distance from  $A'$  to  $C'$  must be equal to or less than the distance  $AC$ , but if  $A'C'$  is less than the distance  $AC$ , the cut is brought to the proper length by making it curved as shown in an exaggerated fashion in this illustration.

In suturing the lip  $A'$  is brought to  $A$ ,  $C'$  to  $C$ , and  $B'$  to  $B$ , but before suturing,  $B'$  to  $B$  it is necessary to make the incisions  $BZ$  and  $B'Z'$ , the method of doing which is shown in Figure 48. Before finishing the vermillion border, the length of the skin part of the lip on either side from the point of the ala to the mucocutaneous line is checked up for symmetry and if there is a discrepancy in length, it should be corrected at this time (see Figures 42, 43, 44, 45, and 46). No cut is made from  $A'$  to  $B'$  at this time because some or all of the skin included within the area  $A'$ ,  $C'$ ,  $B'$  can be utilized in forming the floor of the vestibule, a place that is sometimes very deficient in lining

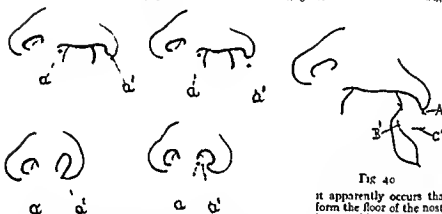
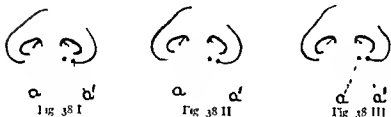
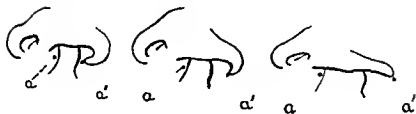


Fig. 39

Fig. 38 Lip incision. Point of the ala. Normally the edge of the border of the nostril which is the border of the ala meets the ala labial crease at a very acute angle that points almost directly toward the midline at the level of the junction of the columella with the lip. In a very slightly spread ala the direction of this point is not much changed the width of the floor being due mostly to the fact that the base of the columella has drifted over to the opposite side (see I in this Figure). In a moderately spread cleft the direction of the point of the ala will be downward and somewhat inward (see II). In the young infant with a widespread complete cleft the ala is drawn into a tight band across the cleft and the direction of the point of the ala is downward and outward as in III. If the *A* is always put in the direction of the point of the ala then when *A* is brought into conjunction with *I* the ala will be pointing toward the midline which is the right direction.

Fig. 39 Lip incision floor of the nostril. Very rarely

the distortion shown in Figure 26B. If necessary, the mattress sutures shown in Figure 27 are used. Before they are put in, however, look at the patient squarely in front to see that there is no downward droop of the inner half of the upper border of the nostril. If there is such a droop or if the inner half of the upper border of the nostril and



Fig. 40

Fig. 41

it apparently occurs that there is not enough tissue to form the floor of the nostril. More tissue for the floor can be gained by moving *I* a few millimeters from the point of the ala but always in the direction of its axis. However this will impinge on tissue that as a rule cannot be spared and as a result the angle of the mouth on that side will be drawn toward the midline. (See Figure 47.)

Fig. 40 Lip incision. Vermilion border. Figure 40 shows a central notch in the vermilion which in our earlier experience in this type of operation was persistently annoying. It was finally overcome by not continuing the cut *CB* directly through the vermilion border but from *B* continuing upward along the dashed line shown in this Figure to include all of the available vermilion as part of this flap. The manner of using this extra piece of vermilion is shown in Figures 48 and 50.

Fig. 41 Vertical measurements. On completion of the approximation of the skin borders of the cleft it is well to measure with calipers the vertical length of the lip on each side as indicated by the dashed lines in this figure. If these are unequal, the cause and correction should be considered at this time.

the corresponding border of the columella make one straight line, then, in a young child, the crescentic excision (Fig. 28) is made. In an adult, the plan in Figure 32 is used (see also Figs. 29, 30, and 31). The steps shown in Figures 27 and 28 are carried in mind and if necessary are used and completed toward the end of the operation.

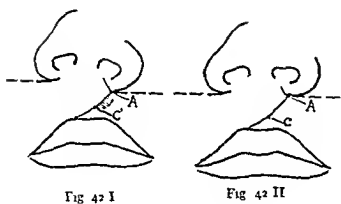


Fig 42 I

Fig 42 II

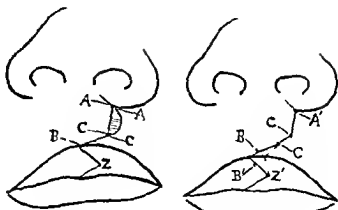


Fig 44 I

Fig 44 II

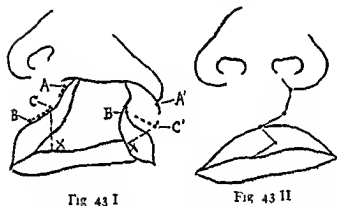


Fig 43 I

Fig 43 II

Fig 42 Lip incision Locating A' We take it for granted that the distance from the point of the ala to the mucocutaneous junction on the sound side of the lip is normal. If it is now found to be shorter on the cleft side than on the normal side, it may be that the point of the ala on the cleft side has been placed lower on that side than on the normal side (see I). By giving more concavity to the incision, A'C' can be shifted up to its proper level (see II) but it may be necessary to replace the original buried chromic catgut suture (Fig 25). It will be noted that when the discrepancy is due to a downward displacement of the point of the ala that it has not disturbed the symmetry of the border.

Fig 43 Lip incision Locating C' If A' has been properly placed, and the distance from the ala to the cutaneous border is short on the cleft side, it will probably be found due to having placed C' too close to the mucocutaneous border, that is, C'A' is shorter than CX, or A'C' is shorter than AC, or both A'C' and C'X' may be short. Usually the angle of the mouth will also be found to be at a higher level than its fellow. For the correction of this see Figure 44.

Fig 44 Lip incision Point C' continued To correct the condition depicted in Figure 43, it is necessary to lengthen the incision A'C' by making it more concave and then suturing C' further along toward B as shown (see II) and to compensate for this, either the flaps C'B'Z' will have to be shortened as indicated in the dashed line in II or the incision CB will have to be extended toward the sound side. Shortening the flaps C'B'Z' as shown in Figure 44 is the more apt to be the correct method.

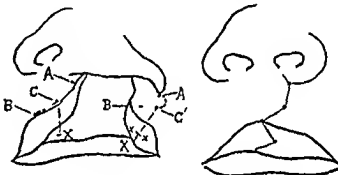


Fig 45 I

Fig 45 II

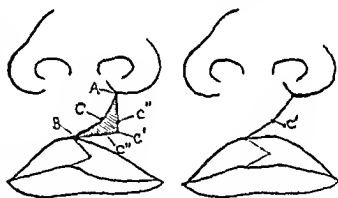


Fig 46 I

Fig 46 II

Fig 45 Lip incision Point C' continued If A' has been put at the proper level, and the distance from the point of the ala to the skin border is longer on the cleft side than it should be as shown in II, this may be due to having made C'A' longer than CX, as shown in I (see Figure 46).

Fig 46 Lip incision Point C' continued This condition is corrected by moving C' downward and outward as shown in I, and then uniting the point C' to C' to give the adjustment shown in II. The striped area shows amount excised in doing this.

The immediate proper adjustment of the lip itself is of secondary importance to that of the nostril. No matter how poor the adjustment of the lip in infants, it will of itself pull the separated halves of the alveolar cleft into a good relationship (Figs 2 and 3). (In older children and

adults with unyielding bone formation, the separation may remain.) But a poor adjustment of the nostril will be followed by increasing deformity of the bones and of the cartilages of the nose.

The most important point in the operation on the lip is not to excise too much tissue from the



Fig 47 I



Fig 47 II



Fig 48



Fig 49



Fig 50 I



Fig 50 II



Fig 50 III

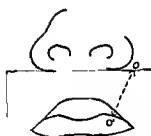


Fig 51 I



Fig 51 II

Fig 47 Lip incision. Point C continued. If the outer lip fragment is deficient in size it will be found necessary to place the point C a little external to the position of 1' as shown in I of this figure and as a result on the completion of the suturing it will be found that the corner of the mouth on that side will be closer to the midline than its fellow. No attempt is made to correct this at the present. If it is in a young baby there will probably be considerable spontaneous improvement with growth.

Fig 48 Vermilion border. To locate the incisions B Z the ends of the Z vermilion flaps are grasped with forceps and drawn across each other as shown in Figure 48. But these flaps are put on very little tension and the incisions are made a little closer to the distal end of the flap than

apparently is necessary and the incision goes through the mucous membrane on the anterior surface of the flap only, the distal part not being entirely detached (See Figure 50).

Fig 49 Vermilion border. The notch shown in the center of the lip was a persistent defect in an otherwise rather satisfactory operation until we learned to conserve all of the vermilion on the outer border of the cleft (see Figure 40).

Fig 50 Vermilion border. I illustrates the defect that is apt to occur when the cut C B (Figure 37) is carried straight across the vermilion. II shows the method of utilizing this extra bit of vermilion (see Figure 40) and III shows the flap in place. As a matter of practice we conserve the vermilion on both sides of the cleft and occasionally the notch is so situated that it is the flap from the Z side rather than the flap from Z' side that we finally use.

Fig 51 Vermilion border. Not infrequently when the lip has been thus far completed it will be observed that the visible vermilion border is too narrow on one or both sides as shown in I. By making an incision on the mucous surface corresponding to all or a part of the line shown in I on one or both sides as may be needed and suturing the mucous lining more toward the midline as shown in II the hidden vermilion will be let down into view. The stripped areas are left raw to be later drawn together by scar. The vertical incision as shown is not always necessary, by running the transverse incision back far enough in the sulcus the mucosa may be stretched.

lip or any at all from the lining of the nose. It should be borne in mind that in wide open clefts of the lip and floor of the nostril, part of the vestibular lining has slumped down until it appears to be on the surface of the lip, in which position it is in danger of mutilation unless the incisions

have been properly planned. Removal of any of the lining causes permanent obstruction of the nostril. Removal of an excessive amount of tissue at the cleft borders will make a lip that is a little too long from above downward or one that is excessively long and flat and shortened from side to

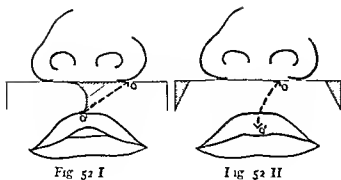


Fig 52 I

Fig 52 II

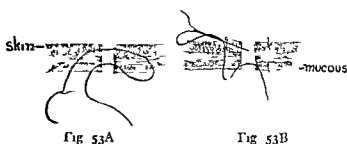


Fig 53 A

Fig 53 B

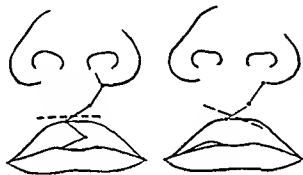


Fig 54

Fig 55



Fig 56

Fig 52 Vermilion border A certain irregularity in the vermilion border at or near the midline can be corrected as shown in this figure For details, see legend under Figure 51

Fig 53 Retention sutures The retention sutures in the lip are usually of horsehair and put in from the mucous surface in the form of a vertical mattress that preserves the full thickness of the lip, A shows the type of suture that may be used with a moderately loose lip, B shows the suture used by Lane It is put in with a straight needle that punctures the skin on each side and re enters through the same puncture hole We find this useful particularly in the double harelip In young babies there is apt to be a suppurative on the seventh or eighth day at the site of the skin puncture, due, probably, to having engaged some of the skin It is annoying to have such a complication occur at this time and to avoid it we make a small stab wound through the skin at each point at which the needle is to emerge and try to make sure that none of the derma is engaged in the loop

Fig 54 Retention sutures In babies with single cleft two of these retention sutures are used The position of the lower one is illustrated in this figure The second suture is put in above the C point In adults, we sometimes use three sutures, one higher up

Fig 55 If there is a little extra fullness of the vermilion visible on one side or the other it can be tucked up and permanently cared for with this suture, if the suture changes the relationship of the mucosa on the two sides

Fig 56 Diagram explanatory of the use of the skin flap A'C'B' in Figure 37 and Figure 24 The incision has been made and the flap is retracting up into the vestibule After the suturing of the lip has been completed an estimate is made of the amount of lining required for the floor and the lateral bulge of the vestibule If there appears to be a real excess it is trimmed along the dotted line A' a', and the resulting cut border is united along the free edge above A The estimate of the amount of lining required should be very generous or the child may return later with a narrowing of the floor in the back part of the vestibule that was not evident after operation

side and with an apparently protruding lower lip, the degree of deformity depending upon the amount of tissue that has been sacrificed Bad suture scars are almost as great an evil (Figs 34 and 35) Correction of these deformities immediately or later is difficult

#### MIRAUULT OPERATION<sup>1</sup>

We have had experience with three different operations consecutively The Mirault type was taken up 10 years ago and has been used ever since (Figs 36 and 37) The Rose<sup>2</sup> operation was

<sup>1</sup>Mirault Operation for harelip J de chir, 1844 n. 257 This is probably the first reference but the operation is illustrated more clearly in H. H. Smith's Operative Surgery 1852

<sup>2</sup>Surgery and Diseases of the Mouth and Jaw p 233

finally abandoned on account of the difficulty in controlling the tendency of the reconstructed lip to be inartistically long The Owen operation, which is a decadent form of the Mirault, was also abandoned because the results were still more objectionable The logic of the Mirault plan is that a flap is taken from the upper part of the lip where there is excess tissue and implanted into the lower border where tissue is most needed As the flap must of necessity carry vermilion border, this plan would apparently be the one best suited to partial clefts with only a slight notch However, we prefer to use this method in all cases of single cleft rather than to risk vitiating the technique by working with different operations



Fig 57 I



Fig 57 II



Fig 58

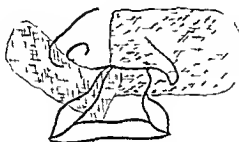


Fig 59 A

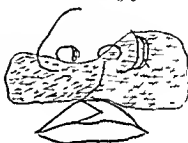


Fig 59 B

Fig 57 I floor of the nose suture. The I I suture does not control the nostril directly and in spite of the chromic gut suture shown in Figure 25 that part of the vestibule lining on either side of the cleft that should form the floor will drop downward into the palate cleft giving somewhat the appearance shown in I of this figure. One or two sutures put in the floor of the nostril with a small heavy Lane palate needle as shown in II completes the tubing of the lining and corrects most of the difficulty. Theoretically one could put in this nostril suture more easily before putting in the A A suture but A A demands the greater accuracy and therefore comes first. It is also our practice to delay the removal of the crescent of skin from the ala (Figure 28) until after the suturing of the floor of the nostril is completed. Only then can one tell accurately just how much of a removal is to be made (Figures 24 and 56).

Fig 58 Nostril retention suture. To protect the union at the floor of the nose and the upper part of the lip during the first 12 days the suture shown in this figure is used, usually of double horsehair. It loops over a flat lead plate

(1 millimeter thick) in the sound nostril well up on the septum and over a molded one in the ala labial fold. Before inserting this suture the hemostatic packing is removed and before drawing the suture taut, the reconstructed nostril is lightly packed with gauze saturated with 5 per cent xeroform ointment made up in vaseline. This keeps the nostril distended to its proper size and prevents a leakage of serum from the nostril onto the suture line which latter is to be kept absolutely clean and free from clots.

Fig 59 A, Hemostatic packing. When the undermining incisions are made no attempt is made to catch the bleeders except possibly in adults but folded gauze is inserted into the undermining planes and pressure is applied from the outside until the active bleeding is controlled. Unless the baby should be in bad condition these packs are removed before the lead plate suture shown in Figure 58 is inserted and are reapplied after this. The approximate position of these packs is shown during and after the operation.

In examining any case of complete single cleft of the lip in a young baby, the following points should be noted:

- 1 The ala is stretched into almost a straight band across the wide open bony cleft and the floor of the nostril is difficult to identify.
- 2 The base of the columella lies obliquely, lower on the cleft side.
- 3 The outer part of the lining of the vestibule has been displaced downward and inward.
- 4 The vertical distance between the point of the ala and the vermillion border on the cleft side

may be shorter than on the opposite side and, therefore, the mouth slit has an obliquity which is the reverse of that of the columella.

5 Though it may not be in evidence, usually enough tissue to make the nostril floor will be found lying below the base of the columella on the cleft side. This is usually supplemented by using all or part of the small triangle between lines of incision on outer side of cleft (Figs 24 and 37).

These are all important features in the topography of the field upon which the ground plan of the new lip is to be laid out.

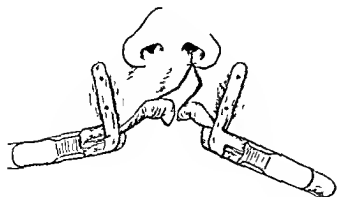


Fig 60

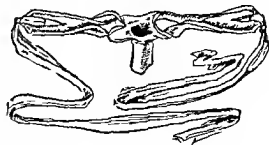


Fig 62

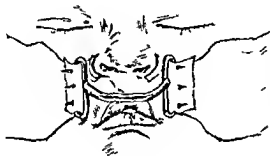


Fig 61A

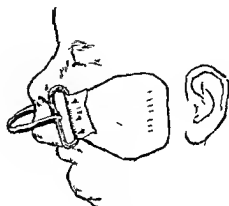


Fig 61B

Fig 60 Haemostatic clamps Shows two angled bull dog clamps on which, to prevent them from slipping teeth have been placed on the outer blade and two corresponding holes drilled in the inner blade. They remain in place while the skin is being sutured. The teeth puncture only the skin.

Fig 61 External support the Logan clamp. Some form of external support is desirable to supplement the sutures. Many plans have been devised for doing this but the only satisfactory one which we have encountered is illustrated. The point that gives it its pre eminence is that Dr Logan made it in the form of a buckle by which the slack which comes from the slipping of the adhesive plaster can be taken up as it occurs. These are put on within an hour or so after the operation.

Fig 62 Breathing tube. Not infrequently the baby will have difficulty in breathing for some days after the recon-

struction of the lip. The nostril that is not obstructed by packing is apt to be insufficient or become obstructed by mucus, and the breathing may be obstructed either by the tongue or lips. This is quite detrimental to the baby. It is restless and loses weight. If such a baby is observed closely it will be seen that there is some obstruction to the respiration at the mouth. If a soft rubber tube is passed into the mouth just to the oral pharynx and fastened in place the baby will breathe comfortably, and the food can be administered with a dropper through the tube or along side of it. The tube can be held by a suture attached to a Logan clamp, or a longer tube can be used which is split as shown in the illustration and fastened to the cheek with adhesive plaster or around the back of the neck with tape. The tube is retained as long as necessary but is taken out of the baby's mouth and boiled at least once every 24 hours. If it is too long, it makes the baby gag.

There is more apt to be an excess than a lack of tissue in the upper part of the lip, and, in most cases, some deficiency in the lower part of the cleft. The Miraault operation has been illustrated with the flap turned from either border of the cleft, but it is our practice always to turn the flap from the cleft side as it is easier to give symmetry to the vermilion border when the line of union is at the midline. It seems impossible, by an acceptable means, to restore the philtrum, but the lack of one bordering ridge is not very noticeable if the restoration is otherwise pleasing.

The plan of freshening shown in the illustrations usually gives a pleasing lip, but every detail

is of importance, especially so is the adjusting of the mucous lining which gives the final little forward protrusion of the central part of the vermilion border that is so characteristically "baby." If the triangular piece of the lip bounded by  $A'C'B'$  is completely removed, there is a tendency to a narrowing of the floor of the vestibule. This has led to the practice of making the cuts  $A'C'$ , and  $C'B'$ , and suturing the skin without detaching the resultant triangular skin flap from the vestibular floor. Later, when the floor is sutured, as much or as little of this flap can be retained as is necessary to insure ample width of the floor of the nostril.



## PRE OPERATIVE CARE

The cleft lip is corrected (over the open alveolar cleft, if such a cleft is present), as soon as possible after birth. During the first few days of life there probably remains some of the immunity to surgical shock which is necessarily present during the process of birth. Operation may be done in the first 24 hours. In our series no deaths have occurred from operations on 24 hour old babies. During the period of jaundice, usually from the fourth to the tenth day, the clotting time may be prolonged and operation is not done in this period. The technique of the operation at this early age is difficult but the advantages to the baby and its mother outweigh the disadvantage to the surgeon.

Thorough physical examinations, as for all surgical patients, are necessary. Active skin infections, respiratory infections—real or suspected—and prolonged clotting or bleeding times are contra indications for operation. The patient having been accepted for operation, feeding should be allowed to within 4 to 6 hours and water to within 2 hours of operation. A final check on the physical condition should be made just before operation. A blood donor should be available.

## POSTOPERATIVE CARE

Immediately after the operation, the baby is put in the care of a special nurse and is kept in the operating room until entirely awake from the anæsthetic and it is certain that the airway is open, that bleeding has ceased, and that shock is not present. Tap water is given by rectum to all patients, and if necessary, saline under the skin. If much blood has been lost or shock is present or suspected in small infants, 20 cubic centimeters of the parent's whole uncitrated blood (without necessity of matching) is given under each pectoral muscle, and the areas are massaged until no lumps can be felt. If the depressed state persists, an intravenous transfusion is done.

The patient is placed on his abdomen to allow blood to run out of the mouth. The continuance of hæmorrhage is closely watched for by the nurse and surgeon. A catgut suture, which is put

through the tongue at the start of the operation, is left in and gives a good sure way of maintaining control of the tongue, and, therefore, the airway, while the patient is waking. This suture is left in, in infants and children, throughout the first night.

Immediate attention is given the lip. It is kept clean of blood and mucus by almost constant gentle wiping with small gauze squares soaked in a solution of equal parts of alcohol and boric solution. This is especially important during the first few hours, as the blood serum that oozes out at this time, if allowed to remain, will make a very hard crust over the suture line.

When fully awake and in satisfactory condition, the patient is returned to the ward. Airways must be kept open, and possible hæmorrhage must still be watched for. Trained nurses and resident physicians are necessary for continued success in caring for these patients. Breathing tubes are frequently used (Fig. 62).

If the lip has been kept clean during the first few hours, the after care while simplified must still be thorough. If crusts form, they may be loosened by wet packs or cold cream and then gently separated from the sutures. If there is superficial cellulitis or infection around the suture line, wet packs should be kept on most of the time. The quartz light is frequently used, both locally and generally.

For the first 24 to 48 hours, feeding is done with a sterile syringe with rubber tip, or with a spoon. After this, the baby may nurse the breast or use the nipple. Water by mouth is given as soon as the child will take it, and feedings are begun the same day. (In repair of palates, nipples are withheld for 2 weeks after operation.) The patient's hands must at all times be kept away from the mouth. For infants, a special cuff of wooden tongue depressors sewed into cloth is tied around the arm. These may be incorporated in the sleeves of the under jacket. For older children (and adults if necessary) padded anterior wooden splints are applied to prevent flexion of forearm.

The packs under the lip are removed in 24 hours. The skin sutures are removed in 5 days and the deep sutures in 12 days.

FROM THE SURGICAL CLINIC, UNIVERSITY OF ZURICH  
CHONDROMATOSIS OF THE JOINT CAPSULE

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CHONDROMATOSIS of the joint capsule, first described in the year 1900 by Reichel, is a condition about which little is known. In the English literature contributions to our knowledge have been made by Henderson and Jones. More recent articles on the subject may be found in the German surgical literature. Of late the disease has been recognized more often because of this interest. For example, Forssell's X-ray plates showed the disease but he did not so name it. The X-ray plate is still the only safe means of diagnosis. Therefore, more X-ray plates of joints must be made in ill defined joint disease. It is true that even an X-ray plate may be a source of error. Schinz, in his compendium, states "The cartilage foci may not be discernible in the X-ray plate, they become visible only when they calcify and ossify at the center." Hesse describes a case in which chondromata were present but they were not apparent in the X-ray film. Even though visible as chondromatosis in the film, it may be described as osteochondromata. One should say that a chondromatosis of the joint capsule is not an ossification but a calcification. With these exceptions the X-ray picture is, and probably will remain, the decisive factor in diagnosing chondromatosis of the joint capsule.

In spite of the fact that chondromatosis of the joint capsule was described 30 years ago, many authors still are concerned principally with its etiology. They apparently have given up the theory of Reichel—the transformation, the result of an infectious process, of the synovial membrane into a cartilaginous tissue. At the present time two other theories occupy the foreground in the literature: the tumor theory and the theory of the origin on a metaplastic basis as a result of chronic irritation. The principal proponent of the first theory is Lexer with whom Janker, Jones, Henderson, Rostock, and others agree. The hypothesis of Mueller that chondromatosis of the joint capsule is a malignant formation or tumor may be refuted, as one could never be certain that an infiltrative growth was present. The advocates of the latter theory are, among others, Lotsch and Beckmann Ivarsson.

As we are not in possession of material obtained at operation for the purpose of microscopic study,

we cannot take a definite stand as to the question of etiology. However, we believe that the relatively great number of cases in our series not only justifies a report of them but we believe from our experience with them that we are in position to make a statement as to the etiology.

While there are still many acknowledged facts regarding the complex subject of chronic traumatic and non-traumatic lesions of the cartilages (such as osteochondritis dissecans, arthritis deformans), there are still differences of opinion among the different authors. Kappis states "The arthritic formation of cartilages in the capsule becomes in part so overrich that, on macroscopic examination, one may gain the impression that the lesion is not an inflammatory process but rather a tumor formation." Haberer says that the genesis of chondromatosis is not on the basis of a formation of tumor tissue.

A consideration of the actual facts, however, permits us to say that there are graded transitions between osteochondritis dissecans on the one hand and arthritis deformans on the other and also that there are transitions between the latter and chondromatosis. We believe that chondromatosis of the joint capsule is a disease entity and would wish to apply this fact in a theoretical sense rather than in a clinical one. Therefore, in speaking of this disease, we would prefer to use the term "chondromatosis" with secondary arthritis deformans, in the same sense that Axhausen used the term.

In Case 6 we have a case of chondromatosis in a congenitally deformed elbow joint. We believe that in this case it would be logical to search for the etiological factor in a disturbance of development. Nevertheless we believe that this mode of origin should not be considered as the usual one even though such a theory might be applied in the majority of cases.

This leads us to the very important question of the influence of a traumatic factor in the origin of chondromatosis. Trauma, as an etiological factor, is naturally refuted by the adherents of the tumor theory, but it is accepted as a contributing factor at least by some authors (Boehm, Hesse). In our opinion even a single trauma might be sufficient to cause a joint, altered by chondromatosis, to



FIG. 1. Myositis ossificans after luxation of the elbow joint. The ossifications are not in the joint capsule but in the muscle insertions.

become painful and therefore unfit for function. On the other hand we believe that chronic repetition of a trauma should not be rejected as a starting point in the etiology of chondromatosis of the joint. An example, therefore, may be seen in Case 9 in which chondromatosis occurred in an elbow joint which had been subjected to repeated trauma, the result of an early separation of a condyle of the humerus. It will hardly be necessary to show the great importance of this question and the many difficulties attendant upon establishing this fact. No doubt every case will have to be judged with the utmost care and as an absolute entity taking into consideration all possibilities of etiology.

The reason the clinical diagnosis is so extremely difficult is that the symptomatology of chondromatosis of the joint capsule may be hidden by the symptoms of some other chronic non inflammable joint diseases or that the chondromatosis itself shows no characteristic symptoms at all. It would be useless to enumerate all of the possible symptoms which chondromatosis might present; no pathognomonic symptom will serve for all cases. But if one has in mind the possibility of chondromatosis of the joint capsule, he should be able to make, in classically advanced cases, a purely clinical, correct diagnosis, in all other cases, however, not to mention the already discussed rare exceptions without calcification, the X ray picture will be the decisive factor in the diagnosis.

In the differential diagnosis first arthritis deformans should be ruled out and then osteochondritis dissecans. Clinically this will be almost

impossible, even if the age and the history reveal certain hints. Only by means of the X ray picture can one distinguish chondromatosis of the joint capsule from the other lesions already mentioned.

We wish to say that an X ray picture of a fully developed chondromatosis of the joint capsule is so characteristic that there may be no reason at all to consider other joint lesions. The roentgenologist will always have only to distinguish the initial stages of this disease from other chronic joint lesions and the differential diagnosis between chondromatosis and osteochondritis will be established. In the latter the cartilage foci in the joint capsule will be missing, they are exclusively intra-articular or only ready to leave the "bed." In case of doubt this "bed" alone will establish the diagnosis between chondromatosis and osteochondritis dissecans, as the "bed" may resemble a defect in the cover of the cartilage of the relative joint surface.

The decision as to whether a chondromatosis of the joint capsule or an arthritis deformans is present as has already been said, will usually depend on the X ray picture. The characteristic variations of arthritis deformans on one hand—as pads on the edges, variation of the shape of the joint ends, defects of the cartilage, and reduction of the joint cleft—and on the other hand the characteristic cartilage islands in the capsule and in the joint in the presence of chondromatosis—with or without secondary arthritis deformans—are so unequivocal that there may be no doubt of the correct diagnosis. The picture is different in cases of arthritis deformans in which cartilage exuberance rises in the joint synovial villi. In such cases it will at times be difficult to be certain as to the diagnosis. All authors state there are really but few arthritic variations in chondromatosis of the joint capsule. Therefore the relative number of the cartilage islands to the arthritic changes will make possible a definite diagnosis. As we believe there is a narrow boundary between chondromatosis of the joint and arthritis deformans, perhaps these borderline cases should be considered as merely transitional forms.

For the experienced observer of X ray pictures, the differential diagnosis between chondromatosis of the joint and calcareous bursitis will not be difficult to make. In addition to the X ray findings, the history will reveal the possibility of hæmophilic joints. The history, the shape, and the position of the calcified plaques will easily establish the differential diagnosis between this and myositis ossificans. Trauma or luxation of a joint (particularly the elbow joint) will hardly



Fig 2

Fig 3

Figs 2 and 3 Right elbow Two small shadows are present near the head of the radius

ever be absent in the history of myositis ossificans. The ossifications may not be found so frequently in the joint capsule as in the muscle insertions and in the ligaments. The structure of the bones may easily be seen with the X ray, and this is not the case in chondromatosis. Figure 1 shows the elbow of a young man of 18 years who had a classic myositis ossificans after luxation of the elbow. Bony deposits are seen especially in the lateral ligaments and show distinct bony structure.

Eleven cases of chondromatosis of the joint capsule were observed in the surgical clinic and the polyclinic in Zurich. I was permitted to study 2 other cases which came from the physical institute for therapeutics (Professor Veraguth), and another case from Professor Clairmont's private practice. The X-ray pictures all belong to the scientific collection of the X ray institute of the "Cantons" hospital of Zurich and have been kindly loaned to me by Professor Schinz. I wish also to mention Dr Friedl, assistant at the X ray institute, who has helped to revise the X ray pictures and has given me his opinion on them.

It is quite interesting to compare the X-ray pictures made at different times. Unfortunately, not all of our patients could be followed. We therefore have only one set of X-ray pictures of many of them. Some pictures have been omitted because they do not show anything in particular or because they are not suitable for reproduction.

CASE 1 N.G. Polyclinic No 3414-28 Patient referred from the medical polyclinic of Zurich with the diagnosis of chondromatosis of the joint capsule. In August 1927 the patient had a paralysis of the right ulnar nerve as a result of pressure. The paralysis disappeared entirely within a year. In August 1927, by way of precaution, an X ray picture of the right elbow was made. This showed near the head of the right radius two small shadows which could not be quite explained (Figs 2 and 3). It was not until 1928 that the patient complained of limitation of motion when stretching his right elbow. Several X ray pictures were



Fig 4

Fig 5

Figs 4 and 5 The same case 1 year later. Calcifications in the joint capsule on the volar side in the radiohumeral joint. Typical chondromatosis.

made at different times. They showed (Figs 4 and 5) a typical chondromatosis on the volar side in the radiohumeral joint. The number and the size of the chondromata grew.

The case shows nothing especially remarkable. It only emphasizes the importance of better follow-up of the patients from time to time if a center of calcification near a joint cannot be definitely diagnosed.

CASE 2 M.E. aged 41 years, Polyclinic No 452-25. In 1909 he had an accident, injuring his right elbow in a machine. He was unfit for work for 3 to 4 weeks. The joint grew thicker but so slowly that the patient hardly noticed it. In 1925 an unexpected sudden movement while he was working produced a severe pain in the right elbow. After this accident he had limitation of motion up to about 110 degrees. Examination on February 5, 1925, showed a swelling of the entire right elbow joint. The swelling felt paste like and granular but was not fluctuating. It did not have the appearance of an inflammation. Extension amounted to 120 degrees flexion to 75 degrees. The X ray picture showed (Figs 6 and 7) that the joint capsule was



Fig 6

Fig 7

Figs 6 and 7 The elbow is surrounded by a great number of round and oblong calcified knots. Near the radius head is a colony of "young" chondromata, only slightly calcified. The head of the radius is enlarged and osteophytes are present in the edges.



Fig 8

Fig 9

Figs 8 and 9 Calcified chondromata in the joint capsule situated only on the volar side of the radiohumeral joint

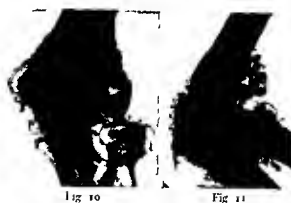


Fig 10

Fig 11

Figs 10 and 11 Both joints (radiohumeral and humero-ulnar) surrounded and partly filled with a great number of strong calcified cartilage bodies arranged in the shape of grapes

interspersed with round and oblong calcified knots of great and hazelnut size. The larger knots showed a light center and a dark peripheral shell. The joint cleft itself showed no calcified knots. Besides there existed a marked arthritis deformans characterized by osteophytes of the edge of the enlarged head of the radius or medial and lateral epicondyles of the humerus. The joint contours were uneven.

The history of this case showed two absolutely similar traumas. As a result of the first the lesion developed without symptoms, but as a result of the second the joint was made unfit for work. The growth of the chondromatosis islands by apposition is beautifully illustrated in the recent roentgenogram.

**CASE 3.** H. W. aged 31 years Polyclinic No. 2027-28. Patient returned for examination to the surgical Polyclinic early in November 1928. In 1905 patient suffered a trauma with strong thickening of the right elbow. On February 10, 1928 he fell on the staircase knocking his right elbow which had previously been absolutely healthy. The joint swelled and became painful and motion in the

joint was limited. Seven days after injury an X-ray photograph was taken and showed a chondromatosis of the right elbow. (The pictures were kindly given to me by Dr. Ruppaner-Samaden.) At that time he had burning pains in the joint and extension was reduced by 25 degrees. Heavy friction was noticeable if the joint was forcibly moved. The X-ray photographs (Figs 8 and 9) showed the typical picture of a purely volar chondromatosis with slight secondary arthritis deformans involvement. Comparison of these roentgenograms with the first X-ray pictures showed that a number of the calcified cartilage islands had increased in size. No chondromata were present in the joint cleft.

In this case as in the preceding, the patient had had two clearly marked traumas, the first having been received some time before the second.

**CASE 4.** J. J. aged 34 years Polyclinic No. 621-24. Unfortunately no details of the history of injury are available among the records of the surgical polyclinic and the patient did not answer our follow-up letter. However the X-ray pictures show such an extensive and typical chondromatosis of the elbow joint that we are reproducing them (Figs 10 and 11). Numerous calcareous cartilage shadows arranged in the shape of grapes are discernible. They partially surround the volar as well as the dorsal side of the joint and lie between the radiohumeral and the humero-ulnar joint.

**CASE 5.** B. I. aged 20 years Polyclinic No. 3184-21. Patient is supposed always to have been healthy. The present illness began 3 years ago when he noticed pain in the right elbow when it was moved. The arm had never been injured. At first extension was restricted; he felt as if there was something too short in the joint. Later flexion was limited. There were times however when he was free of pain. When the weather changed the pain was aggravated. Three months before the examination the patient who enjoyed strenuous athletics began training by lifting and throwing. Thereafter the pain became so much worse that he came to the Polyclinic. The X-ray photograph of the right elbow (Fig. 12) showed intact bones and very sharp joint contours. On the volar side of the distal end of the humerus were a great number of oblong and round bodies. These showed calcification in layers. Cartilage bodies were not definitely shown in the joint.



Fig. 12 Numerous oblong and round distinctly calcified bodies lie on the volar side of the radiohumeral joint. No evidence of secondary arthritis deformans.



Fig 13



Fig 14



Fig 15



Fig 16

Figs 13 and 14 Congenitally deformed right elbow joint. Subluxation of the radius with exostotic thickening of the head of the radius. Osteophytes present on edges.

Joint capsule contains numerous calcified chondromata.

Figs 15 and 16 Same case as in Figures 13 and 14 but the chondromata are more densely calcified and are larger.

The patient did not appear in the follow-up as he was so busy. He wrote that, in his opinion, there had been no change in the condition of the joint, since the year 1921. We, therefore, believe that the condition must be a chondromatosis of the elbow joint which arose independently of a trauma. As the patient is a mason and continues steadily to do the heavy work of his trade, it would seem that the condition of the joint has either remained absolutely stationary or that the development of the chondromata of the capsule has progressed very slowly. The patient is entirely fit for work.

CASE 6 H. A., aged 27 years, Policlinic No. 567-24. The patient stated that since he was 18 years old there has been a certain limitation of motion in both elbows. Early in 1924 the patient had pains in the elbows for 4 weeks. Following this there was limitation of extension. Since then there has been no recurrence of the pains. What troubles the patient most is that he cannot move the joints at once after they have remained for some time in the same position. He therefore has to move the joints slowly at first. For ordinary work the patient has no trouble at all. Both elbows present an abnormal projection of the head of the radius toward the radial side. When passive and quick movements are made the examiner has the sensation on the volar side of the joint of a free body jumping off between his fingers. During such movement the patient suffers pain. Active motion causes no pain. At no time is there an appearance of squeezing in. Strong grating is noticeable in both joints, but is more marked on the left than on the right. Pronation on the left side is impossible and on the right side is very limited. The left arm is continually kept in a fixed middle position. Flexion on both sides is possible up to 60 degrees, extension up to 130 degrees. The X-ray pictures of both elbows are absolutely identical. Figures 13 and 14 are photographs of the right elbow. Pea and hazel nut sized calcified capsule chondromata are seen in the capsule of the radiohumeral and the humero ulnar joint. Besides, there is a congenital anomaly, a subluxation of the radius with exostotic thickening of the head of the radius. The head of the humerus is not fully developed but is in only a rudimentary stage. Large osteophytes are present on the edges, a sign of a marked arthritis deformans. As

compared with pictures taken in 1924. Figures 15 and 16 taken in 1928 show a distinct increase in the capsule chondromata.

The diagnosis would, therefore, seem to be a chondromatosis of the joint capsule in a congenitally deformed joint. As already stated, we attribute the lesions in both elbows of this patient to co-ordinated disturbances of development. It is remarkable that the patient can correctly carry on his work as a mechanic in spite of the high grade deformity of both elbow joints.

CASE 7 K. J. aged 15 years, patient of Prof. Clairmont. This youth stated that he was hindered in extending his right elbow while playing tennis. He complained of no other difficulties. Examination of both elbow joints showed nothing remarkable except the limitation of extension mentioned. To determine whether a similar lesion was present on the left side, X-ray pictures of both elbow joints were made. Figures 17 and 18 are photographs of the right



Fig 17



Fig 18

Figs 17 and 18 Right elbow. One round shadow is seen on the volar side of the humero ulnar joint. The form and construction are typical for capsule chondroma.



Fig. 19



Fig. 20



Fig. 21

Fig. 19 Severing of epiphysis of the epicondyle humeri

Figs. 20 and 21 The same joint as Figure 19 9 years later. Calcified chondromas in the capsule of the humero-

ulnar joint. Great osteophytes of the edge on the radius head. Osteophytic layers on the place of the internal epicondyle of the humerus.

elbow. A round lime shadow of stratification is present on the volar side of the radiohumeral joint. The roentgenologist suggested a probable diagnosis of movable foreign body. The patient wished to be operated on so on September 1, 1928, an arthrotomy of the right radiohumeral joint was done. Together with the synovia two very small strong gray knots came out when the joint was opened but no movable body could be found in the joint. However, the body seen in the X-ray photograph on the volar joint capsule insertion of the humerus was found to extend into the joint as a cherry stone sized prominence which was excised. With the probe the eminentia capitata felt somewhat softer than the other cartilage.

Roentgenograms of the left elbow also showed calcified cartilage islands of somewhat smaller size within the capsule of the radiohumeral joint.

In this case the diagnosis would seem to be chondromatosis of the joint capsule in both elbows in spite of the fact that the patient was a young boy of only 15 years of age. The history of a trauma could not be found. The softness of the cartilage on the eminentia capitata may be considered as the very beginning of an arthritis deformans. Because the patient went abroad a follow up examination could not be obtained.

CASE 8 S. G. Polichnik No. 552-25. In July 1916 patient slipped in a stable and apparently fractured the right arm near the elbow. He was treated at the surgical clinic. The X-ray picture taken in 1916 (Fig. 19) showed no fracture but an old separation of the epiphysis of internal epicondyle of the humerus. The patient afterward worked without difficulty. Later however he suffered increasing pain and limitation of motion in the right elbow which caused him to visit the clinic. The epicondyles were sensitive to pressure. At the side of the lateral epicondyle of the humerus down in the pit toward the olecranon was a free body which could easily be moved. Extension was

possible to 130 degrees flexion to 80 degrees. Extreme pronation and supination were painful. The X-ray pictures made in 1925 (Figs. 20 and 21) showed typical chondromatous involving principally the capsule of the humero-ulnar joint. In addition enormous changes resembling arthritis deformans—osteophytes on the head of the radius—were present on the ulna and on both epicondyles. Osteophytic layers were seen on the medial side of the metaphysis of the humerus. The joint contours were uneven, the joint cleft moderately narrowed.

The enormous variation in this elbow joint must be due to a trauma (separation of the epiphysis) which was not recognized although it probably had been present since earliest youth. In all probability the chondromatosis and arthritis deformans may not be considered as the origin and cause of the difficulty but as co-ordinated factors in the production of the chronic irritated state of this joint.

CASE 9 Polichnik No. 3187-28. Patient was 60 years of age. The history at the time he entered the surgical polichnik revealed that patient had had much pain. Since early in 1926 he had had pain in the right knee which was especially noticeable when he arose from a sitting position and while he was standing on his feet and as well when he mounted stairs but he had no pain when he walked on level ground or when he sat still. Patient had consulted no less than 7 or 8 doctors. He had received all sorts of treatment including the violet and X-rays and he had taken all kinds of medicine and household remedies but had not been relieved. With the exception of very slight thickening the right knee showed no pathological conditions. However, flexion and extension were greatly restricted and caused pain. The joint was also sensitive to pressure to the side of the patella where the patient stated he was injured years ago. The X-ray photographs (Figs. 22 and 23) show calcified chondromatous knots varying in size from that of

a pea to a bean on the back of the right knee joint. The chondromata involved the joint cleft. No osteophytes were present on the edges, the joint contours were rough. Calcified chondromata were present in the metaphysis of the right femur.

The presence of chondromatosis of the joint capsule and at the same time bone chondromata would indicate a congenital genesis. Whether the pain and the limitation of motion of the right knee had been due only to the chondromata of the capsule, which really were not so large, or whether the pain had been caused by arthritis deformans in the right hip, cannot be definitely stated. But as the left hip and the left knee were absolutely normal it is very probable that the chondromatosis was the original lesion and the arthritis deformans of the hip was produced only by the inactivity of the knee.

**CASE 10.** G. E., aged 42 years, female, teacher. The patient had had pains in her knees for a long time. She was not quite sure whether the left or the right knee gave the most trouble. Her knees frequently gave way and she felt very unsafe. She could give no reason for the affection. In the year 1926 she had had a course of medical treatment and her condition rapidly became better after a course of sea baths. She evidently never did have strong knee joints. In August, 1928, the pain in the right knee returned, probably caused by a sudden movement. This joint since then has shown the typical squeezed in appearance. The knee was swollen, the contours somewhat deformed, especially the upper part being bent upward and to the side. The patella was movable, the knee could not be entirely extended but stopped at about 165 degrees. Extension was painful. There were no abnormal movements and no free body could be palpated. Circumference 34.5 centimeters. With all movements there was a marked cracking sound. Examination of the left knee showed no effusion, normal mobility, heavy cracking when moving and circumference 33 centimeters. The anteroposterior X-ray photographs of both knee joints and the lateral X-ray picture of the right knee joint (Figs 24 and 25) show pea-sized and bean-sized calcified cartilage shadows especially on the front side of both knee joints. Arthritis deformans was also present in both knees, the lesion being more pronounced on the left than on the right side. Roentgenograms made in 1928 showed that the lime deposits had increased and that the layer of the calcified bodies had changed. Free joint bodies had already appeared on the right side and this would explain the appearance of the joint.

This was a case of typical chondromatosis of the joint capsule of both knee joints for which no satisfactory cause could be found. The fact that the lesion was bilateral would suggest a congenital genesis. The cartilage bodies showed very slow growth. However, in the right knee they have begun to separate from the capsule. There seems to be no explanation for this or the fact that it did not happen also in the left knee.

**CASE 11.** H. E. aged 36 years No 2237-28. The patient had been conservatively treated in a hospital for a foreign



Fig 22

Fig 23

Figs 22 and 23. Right knee. Small round shadows in the joint cleft and in the back of the capsule. Calcified chondromata in the metaphysis of the humerus.

body in the left knee. The knee at that time had been greatly swollen and could not be fully extended. The patient believed that the lesion was caused by the fact that he had to do most of his work in a kneeling position. In 1914 he suffered a new knee joint effusion. For the past 3 years he has had intermittent pain in the knee and sometimes the onset was so sudden that he could scarcely bend the knee. The patient had noticed on the posterior middle portion of the knee an odd body which protruded but which he could press back himself, when this body had been replaced the pain disappeared. One day early in September 1928, the patient suddenly arose from the kneeling position whereupon he felt such a sharp pain that he could not extend the knee and could not stand on his left leg. He massaged the knee with a rotating movement and thus succeeded in relieving the condition. These attacks have since that time been repeated as often as 20 to 30 times a day. The patient could always feel an odd body, sometimes at the side, sometimes in the middle of the patella and sometimes under the quadriceps tendon. The patient had always been successful in eliminating the pain by the movement described. The left upper thigh showed 2 centimeters atrophy as compared with the right. Complete extension was possible but flexion was moderately restricted. The X-ray photograph showed a round, calcified body in the knee joint cleft (Figs 26 and 27) and another one in the rear portion of the joint capsule near the head of the fibula. It was supposed that two free bodies were present in the left knee, and operation was advised and carried out in October, 1928. The left knee was opened through a Payr incision, which made possible a close survey of the whole joint. In the upper recess an odd body the size of a cherry was found and removed. A second free body, however, could not be found in spite of the fact that a very close scrutiny of the joint was possible and that a diagnosis of such a body had been made. The second free body was evidently in the joint capsule. The control photographs of 1929 showed that the free body which could





Fig. 24



Fig. 25



Fig. 26

Figs. 24 and 25 Anteroposterior view of both knees and lateral view of right knee. A great number of round not

greatly calcified bodies are seen principally on the front of the joints

not be found at operation still lay in exactly the same position as it did in 1928. The roentgenograms also showed three other round bodies slightly calcified in nearly the same position as the free body removed at operation. The follow up examination showed no effusion in the left knee joint but severe friction with each movement.

The case is interesting for two reasons, (1) The extreme squeezed in appearance caused by a loose cartilage body which made necessary arthrotomy and the removal of the loose body. (2) the follow up after a year showed a recurrence with an even

greater number of capsule chondromata than were present before operation.

CASE 12. R. G. aged 37 years (patient at the Institute for Physical Therapy). Seven years ago patient was treated for syphilis and was cured. For the past 7 years he has been constantly treated for sciatica of the right side. Acute pains began 3 weeks ago. Day and night he had severe pain extending from the buttock to below the calf especially noticeable when he moved in bed. The pain was so severe he had to limp. Reflexes were absent. Adduction and flexion of the right hip were restricted and painful. There was an area of hyperesthesia and a sense of pressure over the adductors. The X-ray picture (Fig. 28) showed foci of calcification about the size of hazelnuts arranged around the capsule. The joint contours were sharp but there were no signs of a secondary arthritis deformans. The bones showed the atrophy of disuse.

Even if this is a case of advanced chondromatosis we have no right to charge to it all the complaints of the patient. The hyperesthetic area over the adductors and the absence of reflexes may be considered as an expression of the syphilis. The fact that the pains were noticeable especially on movement point to an arthritic genesis. The patient could not be located for follow up.

CASE 13. A. E. aged 45 years. Patient had been treated at the Institute for Physical Therapy. In 1908 he lifted a weight too heavy for him. Since then he has always had backache. In 1925 he came to the Institute for Physical Therapy because the pains had become so severe that he could hardly move. It was thought that he had a sciatic neuritis on the right side. In addition there was a paralysis



Fig. 27



Fig. 28

Figs. 26 and 27 Left knee. In the joint cleft is an ovoid compact cartilage shadow also a smaller round body quite near the head of the fibula.



Fig 28 Right hip Calcified chondrom knots up to the size of peas or hazelnuts lie around the joint The larger show dark borders and clearer centers



Fig 29 Right hip Small calcification foci in the joint capsule and also sharp round calcifications which must be considered as phleboliths In the symphysis region there is likewise a foci of calcification probably prostatic calculi

of the right peroneus, which entirely disappeared after treatment with electrotherapy, but its cause was not learned Patient was discharged without pain but he reentered the Institute for Physical Therapy because of a fainting fit and a spasm of the right calf The stool at this time showed lead and analysis of the blood revealed punctate basophilic erythrocytes Patient worked in an accumulator factory He complained of no pain in the right hip Movements of the right hip were absolutely normal as they were on the left side Patient walked straight and did not limp

The X ray picture taken in 1925 (Fig 29) showed (as did the follow up picture) a chondromatosis of the right hip, marked by lentil-sized, clod like foci of calcification in the capsule The joint contours were sharp There were no signs of a secondary arthritis deformans Besides this there were in the pelvis several circular sharp foci of calcification which undoubtedly were phleboliths In the region of the symphysis there was a calcified body of very irregular shape Whether this was a calculus in the prostate the roentgenologist could only suppose but could not prove

This case is very complicated We have the history of the patient being injured many years ago, of a paralysis of the peroneus which was not explained, and now a proved lead intoxication during the course of which the patient lost consciousness He had suffered many years with a steady backache and sciatic pains which entirely disappeared There was furthermore a chondromatosis of the right hip which, however, had not given him the least trouble We believe that we are right when we say that the chondromatosis had no, or at least no important, role in causing these different lesions X-ray examination of the right hip did not show any variation in the last 4 years, but the hip pain and the radiant pain disappeared entirely The case shows how cautious one must be in diagnosing areas of calcification near joints

CASE 14 U F aged 50 years No 380-26 Patient had been at different times in the chururgical clinic in Zurich and in other hospitals When he was 25 years old he had an inflammatory process in both hips In 1916 a great number

of cartilage bodies had been removed through a longitudinal incision in the inguinal region This operation did not relieve the patient Walking was very painful The inguinal regions are asymmetrical and strong clod like tumors are palpable in them The legs are in marked flexion and exterior rotation Movement at the hips is heavily restricted in all directions This may easily be understood when the X ray picture is examined (Fig 30) On both sides there are calcified chondromata, some of them as large as small apples, partly smooth, partly mulberry shaped, in a very irregular arrangement around the hip joint There is also a marked arthritis deformans of both hips The X ray picture made at different times always showed the same picture

The case represents a very extreme chondromatosis of both hips Arthrotomy and elimination of the free bodies brought no relief The inflammation, if it was an inflammation, of the hip joints reported in the history is no longer evident It may be supposed that even in this first attack the condition was a beginning chondromatosis

#### SUMMARY

This study has disclosed certain facts It is a fact that something is needed to start pain in the presence of chondromatosis We have seen badly



Fig 30 Calcification foci as large as small apples are present around both hip joints in addition to signs of severe arthritis deformans

deformed joints, in which a secondary arthritis deformans is already present and probably has been present for some time and yet the history discloses that the patient has been aware of the condition but a few days. On the other hand we see joints very little deformed and the patients have severe complaints. Some patients show no symptoms at all and the diagnosis of chondromatosis is given only secondary importance. These variations on one hand depend on local conditions themselves, on the other hand on the physical complaints of the different patients. Among local conditions are the presence or absence of locking of the joint, limitation in movement caused by the restriction of space, and pressure on the capsule and the bones. Perhaps the reports of Seeliger (removal of the hydrogen ion values of the synovial fluid toward the acid side in case of arthritis deformans) may cast some light on the subject in this connection. Another factor which must be considered is the matter of compensation with a patient who has accident insurance. If the X-ray picture shows a chondromatosis of a joint which has recently sustained an injury, the insured patient in his desire to receive compensation may be influenced by this fact in stating his complaints.

Further facts may be found in a study of the cases reported. The rate of growth of the individual capsule chondroma and the appearance of new ones vary in the different cases. In every case the growth is very slow. The intensity of the complaints does not coincide with the objective findings.

The principal thing learned is that with conservative treatment and sometimes with no treat-

ment at all, the patients continue to do heavy manual labor. In any event it would seem that patients are more comfortable with a chondromatosis than with an arthritis of the same intensity. It would not be good practice in a patient with arthritis deformans to remove all diseased tissue in a joint or even to reduce the joint itself. On the other hand if the joint presents a squeezed in appearance operation should be done. Arthrotomy and the removal of the free joint body may be considered but symptomatic therapy. We shall do this operation only when absolutely necessary and when we believe that there is constant danger of recurrence.

#### CONCLUSIONS

- 1 Chondromatosis is probably not always caused by the same thing, it may be due to disturbances of development or it may result from chronic irritation of normal cartilage islands of the synovials. In spite of our knowledge in regard to arthritis deformans the cause of chondromatosis as a disease entity is still not settled.

- 2 How great a rôle trauma plays in the etiology must be determined in each case.

- 3 Chondromatosis may be present and yet produce no symptoms.

- 4 Chondromata grow very slowly and are never fatal.

- 5 Treatment must be restricted to healing with the hope that secondary arthritic changes may be prevented. An exception, however, is the case in which operation must be undertaken because function has been interfered with and there is a squeezed in appearance of the joint.

## THE DUODENAL NICHE—A CRITERION IN THE HEALING OF DUODENAL ULCER

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THE first to call attention to the value of the roentgen ray in the study of the changes undergone by an ulcer under medical treatment were Friedenwald and Baetjer. They state that they "can approximately determine the degree of healing of an ulcer which cannot be as certainly determined in any other way."

Ohnell published a series of articles based on results obtained in the medical treatment of gastric ulcer patients from the clinic of Professor Jacobaeus, of Stockholm. He was able to demonstrate the disappearance of a gastric niche by the roentgenological method in most cases, and contended therefore that the assumption that the presence of an ulcer necessarily called for surgical intervention was unfounded. In his experience the average length of time for the disappearance of a niche was  $40\frac{1}{2}$  days. The published evidence consists of silhouettes, which show these changes. The actual roentgenograms are not shown.

Hamburger showed actual disappearance of gastric niche formation in the roentgenogram. In one case in which the gastric niche had disappeared, normal peristalsis was not present in that region, indicating the persistence of induration, and that complete restitution to the normal had not occurred. The demonstration of the disappearance of the roentgen ray evidence of a duodenal deformity is not quite so clear. An important observation made by Hamburger is that although the niche may disappear, a weakness of the wall in that region may persist, and may be the site of recurrence at a later period, with the development of a reactivated ulcer.

Rosenthal published a monograph in 1919 in which excellent roentgenograms of gastric ulcers are shown and the diminution with eventual disappearance of the niche is traced in a large number of cases.

White has noted the disappearance of niche formation in the stomach but has never seen a markedly deformed bulb, representing a duodenal ulcer, return to a perfectly normal rounded contour, in spite of the fact that the patient remains well for a long time and is clinically cured. Such persistent deformity must be considered as due to unyielding scar tissue and adhesions, which, once formed, remain in spite of the actual healing of the ulcer itself.

Buckstein traced the gradual disappearance of a large niche of the lesser curvature of the stomach. Roentgenographic examination was made every 2 weeks, and the retrogressive changes were recorded for a period of 16 weeks.

Shattuck followed the cases that he had been treating, and he found that roentgen observations indicated diminution of deformity corresponding to the improvement of the patients. This was more easily demonstrable in the case of gastric than in duodenal ulcers.

A careful study was made by Diamond. He records the results in 14 cases of gastric ulcer and states that in some patients, under prolonged observation, the niche failed to reappear.

Crohn, Weiskopf, and Aschner reported the results of their observations of 20 cases of gastric ulcer which they followed for periods of from 1 to 3 years. They noted the disappearance of the gastric niche in 10 cases and a failure of diminution in the 8 remaining. The prognosis was influenced by the age of the patient, those in the older individuals showing less tendency to heal because of longer duration of symptoms and sclerosis of the vessels of the stomach and duodenum. The improvement was also affected by the duration of symptoms, healing being more prompt when treatment was instituted shortly after the onset. Several cases showed cyclic remissions, followed by complete recurrence of both symptoms and niche formation. These same authors showed that in 2 cases in which partial gastrectomy was done, a few weeks after medical treatment histological evidence of healing could be demonstrated.

More recently Moutier and Porcher were able to show the complete disappearance of a gastric niche in 4 cases.

Moncref and Nichols observed 17 cases of gastric ulcer for a period of 2 years. The disappearance and reappearance of the niche in these cases was concomitant with remissions and recurrences of clinical symptoms. No relation was found between the length of the history or the original size of the lesion and the rapidity and permanence of healing.

Assmann, and Chaoul and Stierlin in their classic contributions to gastro-intestinal roentgenology record similar evidence of the value of the roentgen ray in determining the progress of gastric ulcer healing.



Fig. 1 Case I A II Duodenal niche present prior to instituting medical treatment

Thus, though an increasingly large literature has demonstrated the roentgenological disappearance of the niche of a gastric ulcer concomitant with the amelioration of clinical symptoms there is a paucity of evidence demonstrating similar retrogressive changes in the deformity of a duodenal ulcer.

Two difficulties arise. An irregular deformity of the duodenal bulb other than niche formation which subsequently shows complete disappearance after medical treatment may create the suspicion of having originally been due to spasm or possibly to incomplete filling. On the other hand a persistent irregularity which remains unchanged in spite of complete clinical recovery over a long period of time does not necessarily mean that the ulcer has not healed. Unyielding scar tissue may be responsible for a deformity that remains permanently demonstrable in the roentgenogram.

A more reliable criterion exists in the study of the changes in the niche of a duodenal ulcer, when this evidence is present. The disappearance of such a niche with clinical cure must be as acceptable as in the case of gastric ulcer.

The duodenal niche as a factor in the diagnosis of duodenal ulcer was first suggested by Barclay

Haudek (15) called attention to the fact that when the duodenal ulcer is penetrating, a niche similar to that in gastric ulcer can be demonstrated, a constant *bismuth fleck*.

Bar referred to a case in which a niche with a gas bubble was present in the roentgenogram, and at operation an ulcer was found on the anterior superior surface of the duodenum penetrating into the liver.

Kreuzfuchs gave a description of the niche, as persistent fleck of bismuth, in the beginning of the duodenum, definitely isolated from its surroundings and sharply circumscribed. Although not present in all cases of duodenal ulcer, it is nevertheless pathognomonic of the condition when found.

Rieder stated that a crater shaped or perforating duodenal ulcer may give roentgen findings similar to those of a callous or penetrating ulcer of the stomach, namely, a niche like area within the duodenum, with localized tenderness on pressure over this region.

Haudek (16, 17) in 1912 and 1913 emphasized two main points of diagnosis: (1) the presence of duodenal stenosis, which may be a sequel, giving rise to contraction or, as an associated concomitant phenomenon due to the presence of the ulcer, namely, spasm; (2) the presence of the niche, con-



Fig. 2 Case I A II Absence of niche one year after medical treatment

sisting of a bismuth deposit within the crater of the ulcer. This is the most valuable sign because it is the only specific one. Unfortunately, it is not so readily demonstrable as the niche of the gastric ulcer. The other points he refers to are either doubtful or of secondary value. These are localized tenderness, hypermotility, hyperperistalsis, hypertonicity, pyloric fixation, and the persistence of shadows within the duodenum other than the niche.

Cole recognized the roentgenological significance of the direct visualization of the crater of a duodenal ulcer and differentiated between the "bullet hole" and "full face" types.

Akerlund, in his classical monograph, has attempted a detailed analysis of the nature of the duodenal deformity that characterizes ulcer in that region. He divides the factors that go to make up the total irregularity into niche formation, retraction in the region of the niche, the defect on the curvature opposite, the eccentrically placed open pyloric lumen, and the saccular dilations.

The niche is the most direct evidence of ulcer, and in his series of 109 cases a niche was found to be present in 60 per cent. It is conical in shape and varies in size from the head of a match to half the size of a pea. It may be found in all gradations of the lesion from the penetrating form to the superficial defect without induration and even when epithelialization has occurred. It is gen-



Fig. 4. Case 2. J. O. Absence of niche two years after medical treatment.

erally present on the lesser curvature border, when present on the anterior or posterior wall, it is near that border. Roentgenologically it is seen as springing from the lesser curvature even when the ulcer is actually at some distance from it. Occasionally the niche may be found springing from the base of the bulb, or present directly within the bulb substance, the so-called *en face* niche. Only rarely is it to be found on the greater curvature side. The demonstration of an actual niche enables the examiner to localize the ulcer with exactness, to determine its relative size, and to employ it as a criterion in determining the effectiveness of medical therapy, in the gradual diminution of its size or complete disappearance.

No account of the significance achieved by the roentgenological demonstration of the niche can be considered complete without reference to the beautifully illustrated article of Berg. He claims to have definitely shown a niche in over 50 per cent of his cases of duodenal ulcer, and considers it the most direct and certain sign upon which a positive diagnosis may be based. With an enviable technique, he has studied the relation of the folds of mucous membrane to the niche. Even in the normal bulb, folds may be demonstrated roentgenologically. In the neighborhood of an ulcer, they may show a radiating convergence



Fig. 3. Case 2. J. O. Duodenal niche prior to treatment.



Fig. 5 Case 3 P. C. Duodenal niche prior to medical treatment



Fig. 6 Case 3 I. C. Absence of niche one year after medical treatment

Of great interest are the variations in the size of the niche during the life cycle of an ulcer. During the period of remission of symptoms either marked diminution or complete disappearance of the niche may be observed. With the recurrence of distress, the niche may reappear.

Carman and Sutherland were able to determine definitely the presence of a niche in only 13 per cent of duodenal ulcers in a large series of roentgen examinations in spite of careful technique which included fluoroscopic observation through every angle of obliquity both right and left, as well as through close approximation of both anterior and posterior walls by palpation behind the screen. In addition, roentgenograms were made in the angle that showed deformity to best advantage. Of greatest significance is the fact that in spite of this relatively small percentage of cases showing the duodenal niche of 100 cases that came to operation 98 were correctly diagnosed. Even in the 2 remaining cases, it is possible that the roentgen diagnosis may have been correct, as the duodenum was not opened. In 3 cases of that same series the diagnosis was not verified until the duodenum was opened.

This would signify that while the niche, when present, is as valuable a criterion as gastric

ulcer, in the last analysis the diagnosis depends primarily on the finding of a persistent characteristic deformity which may be entirely independent of any concomitant niche formation. Only when such deformity is absent or doubtful and the niche is found as practically isolated evidence, does it assume its maximum value. Thus, though the demonstration of the niche gives additional certainty to the diagnosis and enables us not only to determine the location of the corresponding ulcer with precision but acts as a guide in the judgment of therapeutic effectiveness, a roentgen diagnosis of duodenal ulcer may be made with remarkable accuracy in its absence.

In our series at Bellevue Hospital with a technique similar to that of Carman, with repeated examinations where the slightest doubt existed, in a definite effort to determine the maximum number of cases in which a niche could be shown, we found it present in 29 per cent of cases of duodenal ulcer.

Three cases are included in which a niche was roentgenologically demonstrable. Following successful treatment with a modified Sippy regimen it was possible to indicate the complete disappearance of the niche for a prolonged period of time as indicated in the individual case reports in

spite of frequent and careful fluoroscopic and radiographic examinations

CASE 1 A H, aged 26 years had been complaining of epigastric distress for 18 months. She had had periodic remissions of about one month's duration only to have the symptoms recur in a more aggravated form. The pain occurred 2 to 3 hours after meals, was localized to the epigastrium, did not radiate, and was relieved by food. She was occasionally awakened at about 2 or 3 in the morning with pain lasting, for a few minutes. Once she was awake all night with pain. She vomited twice but blood was never found in the vomitus. At one time she noticed blood in the stool. She had lost 20 pounds in weight.

Physical examination was negative except for epigastric tenderness.

Roentgenographic examination revealed the presence of a persistent niche within the duodenal bulb. The stomach itself was normal. No gastric retention of the motor meal was present at 6 hours. A diagnosis of duodenal ulcer was made. The appearance of the niche is clearly seen in the accompanying roentgenogram (Fig. 1). The patient was placed on medical treatment. Her symptoms disappeared. She regained the 20 pounds she had lost. Six months after the first roentgenogram, she was again examined. In spite of the most careful fluoroscopic examination which was repeated several times, with particular emphasis on manual pressure over the bulb as well as numerous films, the niche originally noted was no longer demonstrable. Since then frequent examinations have failed to show any recurrence for a period of 1 year.

Such evidence must be considered as objective proof of the healing of duodenal ulcer.

CASE 2 J O, aged 23 years, had had periodic recurrences of epigastric distress for a period of 3 years. The longest interval of freedom from distress prior to this examination had been 6 months. The distress was epigastric, did not radiate, and occurred a few hours after meals. It was relieved by food. He had never vomited. His bowels were irregular but he had never noticed blood. He had not lost any weight. He gave no history of night pain.

Physical examination revealed tenderness in the right upper quadrant.

Roentgenographic study showed the stomach to be normal. No pathological retention was present. Within the duodenal bulb a niche was demonstrable. This was persistently present during prolonged fluoroscopy and on repetition of the examination. It was also shown in the accompanying roentgenogram (Fig. 3). The evidence of a niche justified the diagnosis of duodenal ulcer. The patient responded readily to medical treatment with complete disappearance of all symptoms and a moderate gain in weight. Two years after the first roentgen study during which time he felt fine he returned for re-examination. At this time, the most careful study fluoroscopically and with numerous films, failed to reveal the niche which had been present.

When a niche is demonstrable its disappearance may be noted as a check upon the efficacy of medical treatment. Roentgenologic study thus serves as a valuable means of indicating objectively progressive changes in duodenal ulcer.

CASE 3 P C, aged 27 years began to complain of abdominal distress 3 months before her first roentgen ray examination. The pain was in the epigastrium and occurred when patient felt hungry. On eating the pain would disappear. The distress was gnawing in character and would recur from 1½ to 2 hours after meals. Frequently she would be awakened at 2 o'clock in the morning with pain.

The ingestion of a glass of milk and some crackers gave her relief in 10 to 15 minutes. She had never vomited or passed tarry stools.

Physical examination disclosed exquisite tenderness to the right of the epigastrium.

Roentgen ray examination showed a normal stomach. Within the duodenal bulb was a large niche. Tenderness was localized to that region. The niche is clearly shown in the accompanying roentgenogram and represents the crater of an ulcer (Fig. 5). The patient was put to bed and treated conservatively. All her symptoms disappeared. One year after the original examination she was again roentgenographed. At this time no evidence of the former niche was present. Localized tenderness was absent.

Here again, roentgenological study has shown excellent proof of the healing of a duodenal ulcer concomitant with clinical improvement. It also shows the significance of demonstrating the presence of a niche. The niche enables us to localize the ulcer, determine its relative size, and study its disappearance in the healing process.

#### SUMMARY AND CONCLUSIONS

1. An historical survey of the significance of the niche in the healing of gastric ulcer is presented.

2. Similar significance from a diagnostic and therapeutic standpoint may be attributed to the niche of duodenal ulcer.

3. Three cases of duodenal ulcer are presented, in which the disappearance of the niche is traced, concomitant with complete amelioration of clinical symptomatology.

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## INTRABRONCHIAL DRAINAGE

ITS IMPORTANCE IN THE DIAGNOSIS AND TREATMENT OF PULMONARY SUPPURATIONS<sup>1</sup>

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IN the study of our cases of lung suppuration and infections which have come to the thoracic surgical clinic at the University of California Hospital, we have attempted to analyze the disease and study its progress by all the usual methods, such as X-ray, bronchoscopy, and diagnostic pneumothorax. We believe that one of the most important factors, which has been frequently overlooked in the study of these cases, is the question of drainage. As has been well said by Yandell Henderson, the lung is the most perfectly drained organ of the body, and its disabilities arise when under any circumstances this drainage becomes deficient.

In our own work we have used the terms "external" and "internal drainage." External drainage is the emptying of a bronchus by cough and expectoration. Internal drainage designates the spilling of pus or secretion from one bronchus into another on the same or the opposite side.

In this paper we propose to show the part that internal drainage plays in the diagnosis and treatment of lung suppurations.

In order to understand internal drainage of the lung and thereby to follow the course of infections, we wish to draw attention to the following anatomical facts.

The carina (Fig. 1) is the vertical partition that marks the bifurcation of the trachea. The carina will permit pus to spill over freely from the right main stem bronchus into the left main bronchus and vice versa (Fig. 3). The right upper lobe bronchus arises from the side wall of the right main stem almost directly across from the carina. About  $1\frac{1}{2}$  inches below this upper lobe opening, the right main stem divides into the middle and lower lobe bronchi. The middle and lower lobe bronchi arise together and are separated only by a thin transverse ridge. This free communication permits drainage and spilling of pus from the middle to the lower lobe and vice versa. The middle lobe bronchus runs toward the anterior chest wall, while the lower lobe bronchus passes posteriorly (Figs. 4 and 5).

The left main stem bronchus divides into the left upper and left lower lobe bronchi at a point about 2 inches down from the carina (Figs. 6, 7, 16).

Note the difference in the position of the upper lobe bronchi of the two sides with respect to the carina and lower lobe openings (Fig. 7). The right upper stands out by itself close to the carina, while the left is  $2\frac{1}{2}$  inches down from the carina. The right is 2 inches above the lower lobe opening, the left is alongside its lower lobe opening. This difference in the position of the upper lobe bronchi is important from the standpoint of intrabronchial drainage.

A clearer understanding of the intrabronchial anatomy and the unusual facilities for the drainage of pus from one bronchus to another is afforded by bronchoscopic examination and lipiodol studies.

The symptoms and signs in pulmonary suppuration are often more dependent upon the areas to which the pus drains than on the actual site of the primary lung lesion. This drainage in turn depends upon several factors, namely (1) the patency of the bronchus, (2) the location of the primary lesion, (3) the anatomical relationship of the bronchial openings, (4) the posture of the patient, and (5) the viscosity of the intrabronchial secretion.

If the bronchus leading to the diseased lobe is not patent the pus will be trapped, atelectasis will follow, and there will be no expectoration or drainage to other neighboring bronchi. This plugging of the bronchus may be due either to extrabronchial or intrabronchial conditions. Apart from tumors, the most common causes of intrabronchial plugging in lung suppuration are chunks of thick inspissated pus, intrabronchial granulations, and inflammatory oedema at the bronchial opening.

These latter conditions are frequently transient, and when sufficient pus is welled up behind the plug, "the bronchial opening is forced" and drainage commences. This type of drainage usually is not adequate and bronchial plugging again follows at a later time. There may be several successions of plugging and unplugging at various periods in the course of the disease. When the diseased bronchus is open, however, the areas to which the pus drains will be determined in a large measure by the viscosity of the pus and the posture of the patient.

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<sup>2</sup>J. J. and Nettie Mack Memorial Foundation

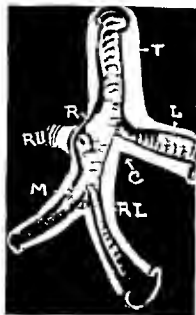


Fig 1 Diagrammatic sketch of right main bronchi T Trachea C carina R right main stem bronchus RU right upper lobe bronchus M middle lobe bronchus, RL right lower lobe bronchus D point of division between the bronchial openings to the middle and lower lobes L, left main stem bronchus

#### MIDDLE LOBE ABSCESS

This relationship of posture and drainage is well illustrated in middle lobe suppurations (Fig 8)

The middle lobe drains best when the patient lies upon his back, but unfortunately this is an undesirable type of drainage since the pus spills into the right main and lower lobe bronchi. Consequently, the symptoms begin when the patient lies down (Fig 9). Because of the spilling of pus, the normal air flow is impaired and the vital capacity is suddenly reduced. This initiates severe paroxysms of coughing and expectoration. The sudden severe paroxysms end as soon as the bulk of the pus is expectorated, but a slow continuous drainage from the middle lobe abscess persists. The abscess continues to spill its contents into the neighboring bronchi during sleep. It first fills the dependent portions of the lower lobe and finally accumulates in such quantities that it "wells up" into the main bronchus and thence into the trachea to spill over into the opposite lung. When the vital capacity is sufficiently reduced, the act of breathing becomes a severe effort and extreme dyspnea, cyanosis, and anxiety ensue.

This picture may last for minutes or hours. Expectoration is hard to start but when once



Fig 2 Lipiodol injection of right tracheobronchial tree C Carina RU, bronchus to upper lobe D point at which the right main bronchus divides into the middle and lower lobe bronchi. Note the distance between the points R U and D

commenced usually gives relief. The attacks leave the patient exhausted.

During the day, however, there is fortunately much less distress than at night. There is little cough and little expectoration since middle lobe drainage and spilling is poor in the erect position (Fig 8). If the pus accumulates in sufficient quantities to overflow from the middle to lower lobes, there is a sudden attack of dyspnea and productive coughing, but this is at infrequent intervals. It is not so severe and does not last as long as the morning or "waking" seizures. The number of attacks during the day is dependent upon the size of the abscess, the rate of pus formation, and the adequacy of drainage. Comparative comfort can be maintained if the patient lies on his back at frequent intervals to drain the abscess posteriorly. He may then evacuate the pus from the bronchi by leaning over the side of the bed, in the usual position of postural drainage.

This clinical picture of middle lobe abscess explains the influence of posture and the effects of undesirable "internal drainage." Thus a patient can be observed during the day when he is up and about and temporarily free of symptoms, but

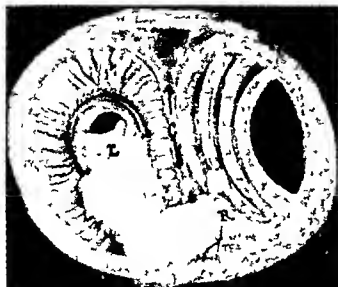


Fig 3. Bronchoscopic picture showing pus freely spilling from a diseased left main bronchus *L*, across the carina *C*, into the right main bronchus *R*. This is the undesirable internal drainage.

upon lying down the spilling starts and symptoms come on with startling rapidity.

Middle lobe abscesses may give practically no abnormal signs over the middle lobe area if the patient has been lying flat on his back for some time preceding the examination. In such a case the pus will have drained into the lower lobe and, on a basis of physical findings alone, at one examination, lower lobe disease will be diagnosed while middle lobe suppuration will be entirely unsuspected. We have had 3 such cases.

#### RIGHT UPPER LOBE ABSCESSES

If drainage is sufficiently adequate to keep up a slow steady "spilling" from an upper lobe lesion, the pus will collect in the dependent areas (Fig 10). One may then encounter evidence suggestive of extensive middle and lower lobe disease with very few signs that point to the real source of the trouble in the upper lobe (Fig 11). In cases of this type there is a mild expectoration but vital capacity is so gradually diminished that no severe coughing paroxysms occur. Following sudden changes in posture and the rapid spilling of pus to obstruct new areas, the cough and expectoration become extreme (Fig 12).

The coughing paroxysms in these patients may result from the reduced vital capacity and is not entirely dependent on the amount of pus within the tracheobronchial tree.

Lipiodol injections teach us considerable concerning the factors which govern these paroxysms.

These lipiodol observations are not made on cocainized patients wherein anesthesia and abol-



Fig 4. Iodized oil injection of the right lung (lateral view). *A*, anterior chest wall, *P*, posterior chest wall, *RU*, upper lobe bronchial branches, *M*, middle lobe bronchus, *L*, lower lobe bronchus. The middle lobe bronchus *M* and the lower lobe bronchus *L* come off the main trunk at the same point *D*. The upper lobe bronchus, *RU*, comes off by itself higher up.

tion of the cough reflex would account for the spilling from lobe to lobe. On the contrary, the oil can easily be introduced into the lung by the passive method without any type of anesthesia and still not initiate cough. But if the patient is suddenly tipped upside down after the oil has collected in the lower lobes, the lipiodol will flow up into the trachea *en masse* and obstruct the entrance and exit of air so that a paroxysm of coughing follows. These masses of oil can be seen under a fluoroscope or on the X-ray plate (Fig 13). The cough is not due to irritation of tracheal mucous membrane since it will occur if the oil wells up in the trachea even in a patient who has been thoroughly cocainized. This relationship of cough and the sudden interference with the normal air flow is particularly striking during bronchoscopic examinations. Bronchoscopically, a cocainized main bronchus can be touched at numerous points at random with a bronchoscopic sponge without exciting cough, but if pus is seen to flow from the depths of the lung so as to occlude this particular bronchus, coughing commences and continues until the pus is dislodged or removed mechanically through the bronchoscope.

Figure 13 shows a mass of lipiodol in the trachea which caused the patient to cough. We have seen this both in cocainized and uncocainized patients. This is, therefore, not a matter of irritability of the tracheal and bronchial mucous membrane but a question of a sudden obstruction of the normal

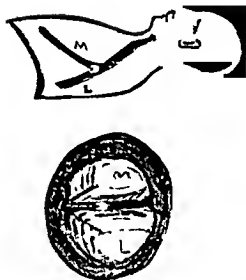


Fig. 5 Upper sketch shows the general direction of the middle and lower lobe bronchi. The middle lobe bronchus *M* runs toward the anterior chest wall while the lower lobe bronchus *L* passes posteriorly. Lower sketch gives a bronchoscopic view of middle and lower lobe openings. *D* Point at which the middle and lower lobe bronchi join to form the main bronchial stem.

air channels with a resultant reduction in the vital capacity. Twenty cubic centimeters of lipiodol slowly introduced causes no cough but 5 cubic centimeters rapidly introduced is sufficient to initiate a paroxysm.

Small amounts of pus near the opening of the right main bronchus can shut off the air to all three lobes of the right lung and reduce the vital capacity to a marked degree while rather large collections of pus in a single lobe at the base can be well tolerated as air can then freely enter the remaining portions of this lung.

The "head down" position will evacuate pus that has spilled to the middle and lower lobes during the day. This posture, however, usually leaves the upper lobe abscess undrained except in abscesses situated at the base of the upper lobe (Fig. 14). If the patient lies on his right (affected) side during the night, the abscess cavity completely fills with pus and slowly overflows into the dependent bronchi. When the patient awakens, one or more of the adjacent bronchi will be so completely filled as to prevent the entrance of air. At this time dyspnea and wheezing will be marked, the patient will be completely choked up, and the coughing and expectoration



Fig. 6 Lipiodol injection of left lung showing the main anatomical divisions of the bronchi. *C* Carina. *D* point of division between the bronchus to the upper lobe *U* and lower lobe *L*. The two unlettered arrows indicate the course of these two main bronchi.

will be violent and persistent. These symptoms will continue until the pus can be dislodged from those areas that most seriously embarrass breathing.

#### RIGHT LOWER LOBE ABSCESSES

It is not easy to diagnose positively a right lower lobe lesion on the basis of abnormal lower lobe signs. We have seen several patients who, on careful examination, showed evidence of disease at the base and still, after lipiodol injection, bronchoscopy and operation, were proved to have primary upper lobe lesions even though no abnormal physical findings were elicited over the upper lobe (Fig. 11). Examination with the patient in different positions at various times during the day and night would have prevented this error since the location of physical findings in these cases is determined by the spilling due to posture.

The deductions to be drawn from physical findings are to be based upon several examinations at various times of the day or on separate days after the patient has assumed various postures for several hours preceding each examination.



Fig 7 Anatomical specimen showing the anatomy of the tracheobronchial tree *P*<sup>1</sup>, Left lung, *P*<sup>2</sup>, right lung, *C*, carina, *R*, *U*, right upper bronchial opening, *L*, *U*, left upper lobe bronchial opening, *D*, division between the right middle, *U*, and lower lobe bronchi, *R*, *L*, *T*, trachea, *R*, right main bronchus, *L*, left main bronchus, *L*, left lower lobe bronchial opening. The distance between the right upper and lower bronchial openings is not so great here as is usually the case



Fig 8 A sketch and bronchoscopic view of a middle lobe abscess with patient in the erect position *U*, Pus filled middle lobe bronchus, *L*, normal lower lobe bronchus, *A*, abscess of the middle lobe is close to the anterior chest wall. In this erect position pus from the middle lobe abscess must flow up hill in order to drain. Therefore drainage and spilling, are slight

#### LEFT UPPER LOBE ABSCESSSES

Abscesses at this location follow the same general plan of spilling that has already been noted. Because of the nearness of the main bronchial openings on the left, pus spills from left upper lobe abscesses into the left lower lobe to give abnormal physical signs over this lower region (Fig 7). Pus can then drain across from the left lower lobe into the opposite lung (Fig 15).

We have recently seen a proved case of left upper lobe abscess in which there were just as many abnormal signs over the lower lobe as over the diseased upper lobe. Two other cases of this type have been studied. One was a boy of 16 years. He was seen because of a chest complication 2 days after an appendectomy. When the patient was examined lying flat on his back, all the abnormal physical findings were limited to the upper lobe. The lower lobe findings were normal. As soon as the patient was placed in an extreme Fowler position, the abnormal signs disappeared from the top, but an impaired percussion note, along with rales and diminished breath sounds, was noted over the lower lobe which had previously been perfectly clear. This migration of signs occurred almost instantaneously with the change of position. The third case of migrating signs occurred in an elderly woman 2 days after a hip fracture. The initial examination in the flat position showed all the abnormal signs over the left upper lobe (front and back), while the lower



Fig 9 Sketch to illustrate the influence of posture on the drainage of middle lobe abscesses. Note pus spilling from the middle lobe bronchus *U* into the lower lobe bronchus, *L*. *A*, Abscess of middle lobe. Lower sketch shows bronchoscopic appearance of the pus filled middle, *U* and lower, *L*, lobe bronchial openings with the patient lying upon his back. This interferes with the entrance of air to these two lobes

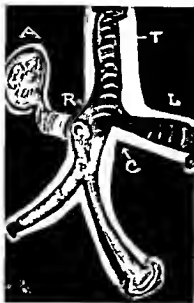


Fig 10 Diagram showing sites to which pus spills from an upper lobe abscess if the upper lobe bronchus is open and the patient is erect. A Right upper lobe abscess R right main stem bronchus C carina L left main stem bronchus P pus collecting in the middle and lower lobe bronchi. One bronchus is fairly well filled up with pus and will give physical signs of a drowned lobe or possibly atelectasis while the other bronchus has only its mouth occluded. The signs over this latter lobe will suggest an obstructive emphysema. If the bronchial opening is only partially occluded with pus there will be an audible expiratory and inspiratory wheeze.

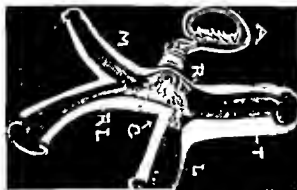


Fig 12 Diagram of pus spilling from a right upper lobe abscess when patient lies on his left side so as not only to obstruct the right main bronchus R but also to occlude the left main bronchus L. Pus has spilled across the carina C. The entire lung is not filled with pus but the two main bronchi are occluded and no air can enter either lung. Vital capacity is suddenly reduced and cough ensues. All degrees and varieties of this spilling can be encountered. Physical signs of partial obstructive emphysema with inspiratory and expiratory wheezes are noted over both lung fields. Patients with right upper lobe abscesses cannot lie on their left sides because of this constant drainage and spilling into the left bronchus.



Fig 11 Iodized oil injection of right lung. The arrow indicates the dilated bronchi at the base of the right upper lobe. A previous roentgenogram without lipiodol showed no evidence of right upper lobe disease. All the abnormal physical findings were over the middle and lower lobes. The location of these abnormal physical signs can be explained on a basis of internal drainage and spilling of pus from above. Operation confirmed the lipiodol diagnosis of upper lobe bronchiectasis and showed a normal middle and lower lobe.

lobe was normal. After assuming the Fowler position and instituting deep breathing exercises, the left upper lobe cleared up instantaneously but the riles appeared over the lower lobe. In these 3 cases, posture and drainage have been the influencing factors in determining the location of abnormal physical signs.

#### LEFT LOWER LOBE SUPPURATION

Left lower lobe abscesses spill their contents into the left upper lobe when the patient lies on his affected side, but the pus spills across the carina into the right upper lobe when patient lies on the right side. This tendency to secondary right upper lobe involvement is due to the high anatomical position of the right upper lobe bronchus (Figs 1 and 7).

Lipiodol injections in unanesthetized patients illustrate very well the susceptibility of the right upper lobe to accumulate pus from the left lower lobe (Fig 15).



Fig 13 Lipiodol introduced into unanesthetized bronchial fistula of right lower lobe with patient lying on left side. Note the spilling of the lipiodol over from the right lower into the left upper lobe. *I*, Point of injection through bronchial fistula, *L*, chunk of lipiodol in the trachea



Fig 14 Lung abscess of right upper lobe that best evacuated itself in the "head down" position. Arrow indicates the "mouth" of the bronchus leading to the abscess. Right upper lobe abscesses usually drain best when patient is erect rather than down

On bronchoscopy, we have seen 2 patients with chronic left lower lobe suppuration in whom there was a collection of pus along with marked redness and edema at the right upper lobe bronchial opening. These right upper lobe bronchoscopic observations might so mislead one as to make a diagnosis of primary right upper lobe disease. In these cases, however, the right upper lobe was normal on lipiodol examination and the abnormal bronchoscopic changes in the right bronchus must therefore be interpreted on a basis of "spilling" due to the intrabronchial drainage. The bronchoscopic examinations and lipiodol injections have been decidedly helpful in interpreting and evaluating the physical signs.

The physical findings in lung suppurations are similar to those noted in patients after lipiodol injection and in each instance alter in position after changes in the posture of the patient. These findings must, therefore, be on a basis of fluid or secretion (pus) in the tracheobronchial tree. Lipiodol studies and the accompanying roentgenograms give us a fair conception as to the mechanism of intrabronchial drainage. The areas to which lipiodol can be spilled on changes of posture are identical with those at which abnormal physical findings are elicited in lung suppurations following similar postural changes (Figs 13 and 15 to 19). Lipiodol introduced into the left upper



Fig. 15 Lipiodol introduced into a bronchial fistula of the left lower lobe without the use of cocaine or any type of anesthetic. Patient is lying on his right side. Note the flow of lipiodol into the opposite lung plainly to fill the right upper lobe. There were no râles over the right upper before lipiodol injection. Coarse moist râles appeared after the lipiodol "spillover." Pus will likewise spill from the left lower lobe into the right upper with the resulting production of abnormal physical signs. This illustrates the influence of posture on intrabronchial drainage





Fig 16 Lipiodol introduced by passive method (through the mouth) without any type of anesthesia into the left lung with the patient in erect position. Note the absence of lipiodol in right lung. C Carina L C left upper lobe bronchus L I left lower lobe bronchus D division between upper and lower lobe bronchial openings

lobe will flow to the left lower lobe when the patient assumes the erect position and similarly the migration of abnormal physical findings from the left upper to the left lower lobe has already been demonstrated in 3 cases of intrabronchial secretion without lipiodol.

With the X ray we can follow the 'lipiodol spilling' from one portion of the lung to another with changes in the posture of the patient but this cannot be so easily done with pus alone, which does not cast a shadow comparable to lipiodol. However, since many lung suppurations and lipiodol cases have similar physical findings and identical alterations in the findings on postural changes, it seems fair to conclude that the 'spilling' takes place in each instance. Bronchoscopic examinations confirm this conclusion.

#### 1RACTICAL APPLICATION

This undesirable 'internal drainage' is not limited to lung suppurations but is noted also in certain cases of pneumonia, tuberculosis, sinusitis, and carcinoma of the esophagus. The recog-



Fig 17 Same patient as in Figure 16. Roentgenogram taken after patient lay on the right side for 20 minutes. The lipiodol has spilled over from the left lung into the right upper and lower lobes. Pus will pull over in similar fashion. This illustrates the undesirable internal drainage.

nition of this type of drainage is of a decidedly practical value in the management of these cases.

Internists are familiar with the so-called migrating pneumonias. It is noteworthy that these often occur at a right top and then at the left base. Because of the anatomical arrangement, it is easy for pus to spill from a right upper lobe bronchus across the carina into the left lower lobe. Internal drainage seems to account for these new areas of pneumonia in such cases. We are studying these conditions at the present time and believe that many of them are due to "spill over" from the original upper lobe lesion.

Thoracic surgeons are cognizant of the unusually poor gas or ether anesthesia taken by certain lung abscess patients. This is particularly true in patients who have copious expectoration. During the operation the patient is usually lying with the diseased side uppermost and this permits pus to spill across the carina into the dependent opposite lung so as to obstruct the air flow to the good side. Rapid breathing and cyanosis ensue and if the pus is not dislodged, death will follow. If the patient is unable to expectorate the accumulated pus because of weakness, pain, narcosis or lack of support of the chest wall after a first stage lung abscess operation this 'spill over' to the opposite lung will occur. This has been clearly demonstrated in a patient with lung abscess (300 cubic centimeters expectoration in 24 hours) who had a



Fig 18 Lipiodol introduced by the passive method (through the mouth) without any type of anaesthesia into the right lung with patient in erect position. There is a small amount of oil at the left base.

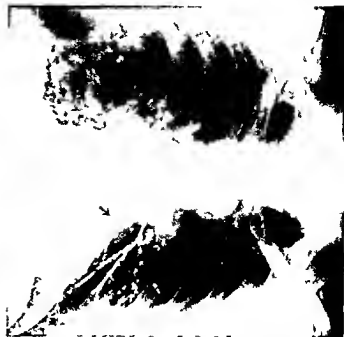


Fig 19 Same patient as in Figure 18. Roentgenogram taken after patient had been lying on the left side for an hour. The lipiodol has spilled from the right lung into the left side.

first stage lung abscess operation with multiple rib resections and suture of the lung to the chest wall without open drainage of the abscess itself. Morphine and scopolamine anaesthesia had been used. The patient had great difficulty in evacuating the pus postoperatively. He became cyanotic and respirations were rapid. Coarse rales (inspiratory and expiratory rhonchi) appeared over both lungs. He died on the third day. At autopsy, in addition to the pus in the diseased right lung, the left main bronchus and left lower lobe were also filled with pus. Before operation the left lung was clear, and this left sided pus must be explained on a basis of overflow from the right side, especially since no abscess was found on the left side at autopsy.

A patient with a right sided lung abscess, operated upon by cauter pneumonectomy, did beautifully until the third day after operation except for a slight amount of bleeding from the wound which seemed to be controlled by packing. On the fourth day, however, this patient died suddenly and unexpectedly. Autopsy showed almost no blood in the bronchi of the diseased lung but there was a large marble sized clot in the opposite main bronchus with an obstructive emphysema of the entire left lung. Death was due

to strangulation, since no air could enter the left lung and the diseased right lung was inadequate to maintain life. Undesirable intrabronchial drainage explains this case of bronchial obstruction. The bleeding from the right lung resulted in a clot which was spilled over or aspirated from the right main bronchus into the left. Bronchoscopy would probably have saved both of these patients.

Before chest operations on lung abscesses, we now examine and treat these patients bronchoscopically to prevent such intrabronchial spilling. Bronchoscopy is repeated at the end of the operation and as often thereafter as necessary.

Pulmonary tuberculosis affords further examples of the practical importance of intrabronchial drainage. Often after a pulmonary haemorrhage there is an extension of the areas of abnormal physical signs. The blood probably spills across the carina into the opposite lung, since abnormal physical signs appear over both sides and, on a basis of physical findings alone, one is at a loss in deciding on which side to induce an artificial pneumothorax. This is especially true if the patient is seen for the first time during the course of a haemorrhage.

The problems of intrabronchial spilling are prominent in the operation of thoracoplasty for pulmonary tuberculosis. In the literature, one cannot help noting the difference of opinion which prevails concerning what should be done at the

initial operation. Some prefer removal of the upper ribs, and others favor resection of the lower ribs at the first stage operation. Removal of the upper ribs at the outset occasionally results in a bronchogenic extension of the disease to the uncollapsed lower lobes. This discussion as to choice of operative procedure resolves itself into one of intrabronchial drainage. Bronchoscopy with removal of the intrabronchial pus either immediately before or after the operation would prevent this spilling and extension of the disease.

The close association of paranasal sinus disease and bronchiectasis has been noted frequently and is considered as due to both lymphatic and bronchogenic extension from the sinuses to the lungs. This bronchogenic extension of nasal secretions during sleep has been well shown with lipiodol by Quinn and Meyer. The free communication between the two lungs permits the spilling of the nasal drippings from one lung to the other and may result in bilateral bronchiectasis.

Carcinomata of the œsophagus furnish additional examples for the study of intrabronchial drainage. In these cases, it is not unusual to find evidence of partially or totally occluded minor bronchi at the posterior portions of the right lower lobe and at the anterior lateral portions of the left lower lobe. The pulmonary signs on the right are in back while those on the left are in front. These signs are due to the œsophageal secretions spilling down over the interarytenoid space into the trachea. The secretions then pass most readily into the dependent areas usually to the posterior part of the right lower lobe. When the patient lies on his left side, however, the anterolateral portion of the left lower lobe becomes the most dependent area. We have noted this bilateral distribution of abnormal lung signs in at least 6 cases of carcinoma of the œsophagus and have interpreted it on a basis of intrabronchial drainage.

In a later paper we will present a series of cases

of lung suppuration showing the result of treatment based on intrabronchial drainage. Suffice it to say, however, that the employment of treatment along these lines has increased the percentage of cure and decidedly lessened the number of cases requiring open operation.

#### SUMMARY

1 We feel that proper evaluation has not been given to the mechanical factors which are present in nearly every case of pulmonary suppuration.

2 Intrabronchial drainage has considerable influence on the production of symptoms, course of the disease, its extension both locally and to the other side, and modifies very materially the physical signs which are found from time to time.

3 The diagnosis and successful treatment of pulmonary suppuration are based on an understanding of intrabronchial drainage.

4 Lipiodol and bronchoscopic examinations permit a study of the factors which control this type of drainage.

5 The symptoms and signs in pulmonary suppuration are often more dependent upon the areas to which the pus drains than on the actual site of the primary lung lesion.

6 The part bronchoscopy plays in the diagnosis and treatment of these conditions cannot be overemphasized.

7 We do not undervalue the many other factors which control and modify lung suppurations, such as the type of infection, its virulence, and the method of extension along the lymphatics and the blood stream.

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## PRIMARY CARCINOMA OF THE FALLOPIAN TUBES

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**M**OST new-growths of the fallopian tubes—papillomata, sarcomata, lymphangiomata, fibromata, and carcinomata—are rather infrequent and the greatest majority are recognized only after the abdomen is opened. Their symptomatology and findings are so similar to that of tubal inflammatory processes that differentiation before operation is seldom made. It is the intention of the authors of this paper to discuss the subject of carcinoma of the fallopian tube and to emphasize the symptomatology and findings before and at the time of operation in the hope that more cases will be recognized and properly cared for surgically.

The first authentic case of primary carcinoma of the fallopian tube was reported by Orthmann in 1888. Doran, in 1910, completed an analysis of an additional 32 cases. In 1926 Wechsler, in an excellent review of the literature, summarized a collection of 192 cases and added 4 of his own. With the cases reported in the past few years it is safe to conclude that there are well over 200 authentic cases on record.

Norris found one case of primary carcinoma of the tube as against 94 uterine cancers in 2,020 gynecological specimens. Vest found only 4 cases of tubal carcinoma in 19,000 patients treated in the gynecological clinic at Johns Hopkins Hospital. In a recent article Callahan, *et al.*, emphasized the rarity of this condition with the following statistics: primary carcinoma of the fallopian tube was found in 0.02 per cent of all gynecological admissions at Johns Hopkins Hospital, in 0.07 per cent of all gynecological admissions at Lenox Hill Hospital, and in 0.31 per cent of all gynecological laparotomies at the Leipzig clinic.

## ETIOLOGY

The majority of reported cases of primary carcinoma of the fallopian tube have occurred at about the time of the menopause. Sixty-six per cent of the cases in Wechsler's series occurred between the ages of 40 and 55. The youngest patient (Bower and Clark) reported was 25 years of age, and the oldest (Mantel) was 73.

The etiology of this condition has been a subject of much interest and some disagreement. The theory that primary carcinoma of the tube arises upon the basis of a chronic, probably purulent, inflammation has been generally accredited

to Sanger and Barth. Doran and others have expressed the opinion that tubal carcinoma represents a malignant change which has taken place in a benign papilloma. Bower and Clark and Norris have stated that in a large proportion of these women there was a history of long standing pelvic inflammation. Contrary to these statements Wechsler found that in only 8 per cent of 196 cases was there any mention of previous pelvic inflammation. He added that gonorrhoeal infection was rarely admitted. Vest, in an attempt to ascertain whether or not the patients had suffered from tubal inflammation, very carefully studied case reports, which included microscopic descriptions, and concluded that inflammation of the tube played a minor role, if any, in the development of carcinoma of the tube.

As further evidence of pelvic inflammation, attention has been directed to the relative frequency of sterility, miscarriage, and abortion in these women. Vest, Wechsler, and others attempted to analyze the statistics appertaining to this phase of the subject, but they were unable to draw any satisfactory conclusions.

Callahan recently reported a case of primary carcinoma of the tube associated with tuberculosis of the same organ. He found only 6 other authentic cases in the literature and concluded that the association was coincidental.

Biar, in his thesis, discussed the possibility of cancer being produced by the excitation of wolfian remnants located in the tube and subjacent structures. Gittleson and others have described cases of tubal cancer which appear to have been secondary to parovarian new-growths. The embryonic rest excitation theory has been employed by a number of authors in an attempt to explain the presence of pelvic new-growths of unknown etiology. This theory, however, cannot be applied to carcinoma of the tube as the microscopic pictures, especially in the early cases, clearly indicate a primary disturbance in the epithelium of the tubal lumen.

The frequent co-existence of tumors of the ovary and the uterus with carcinoma of the tube has been considered from the standpoint of etiology. Kittler's patient, in addition to cancer of the right tube, had a dermoid cyst of the right ovary, a simple cyst of the left ovary, and a myomatous uterus. Other similar cases have

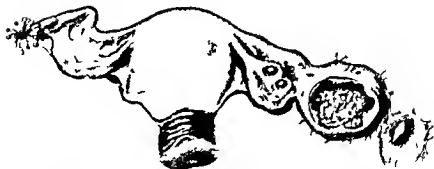


Fig. 1. Distal half of tube opened revealing hemorrhagic papillomatous growth occupying the entire lumen. The proximal half of the tube was patent.

been reported. In his series of 196 cases, Wechsler found the following: cancer in a tubo-ovarian cyst in 10 per cent, a large ovarian cyst separate from the tubal cancer in 8 per cent, a hydrosalpinx of the opposite tube in 10 per cent, and a myomatous uterus in 15 per cent of the cases. There is no evidence, however, to show that the condition of adjacent structures has had any influence on the tubal epithelium which might have led to the development of a new growth.

It is obvious that the foregoing does not permit the drawing of conclusions concerning the etiology of this condition. That evidences of chronic salpingitis are frequently found in association with this disease can not be denied, but it no more explains the etiology than does a chronic infection of the cervix uteri explain the presence of cancer in that organ. The fact that malignant tumors furnish a very fertile media for the growth and multiplication of pyogenic organisms may serve to explain the presence of inflammation in many cases. It is significant that in a number of cases, the present case included the only evidences of inflammation are confined to that portion of the tube which embraces the tumor.

#### PATHOLOGY

**Macroscopic.** When viewed at operation tubal cancer usually has the microscopic appearance of a chronic inflammatory condition of one or both tubes, the disease being bilateral in about one third of the cases reported. The middle and outer thirds of the tube are generally enlarged to form an oval, retort, or sausage shaped mass resembling a hydrosalpinx or a pyosalpinx. The abdominal ostium of the tube is usually closed and not infrequently adherent to the ovary to form a tubo-ovarian mass. The surface is rough or smooth depending on the presence or absence of

adhesions or the penetration of the serosa by the growth. The tumor may be cystic or solid with a consistency which varies with the character of its contents. When the tube is opened the lumen is found to be more or less occupied by a cauliflower like papillary or granular friable mass. The wall is usually thickened but may be very thin when associated with a hydrosalpinx or a tubo-ovarian cyst. The fluid content varies in quantity and quality and may be clear, watery, hemorrhagic, or purulent. Andrews describes a case in which the tumor (tubo-ovarian) contained two quarts of smoky, blood stained fluid.

Metastasis to the retroperitoneal lymph nodes is common and has been noted in some of the very early cases. Peritoneal metastasis is generally limited to those cases in which cancer cells escape through the abdominal ostium or by penetration of the serosa. Direct extension to contiguous structures, especially ovary and uterus is frequently noted. Spencer describes a case in which there was a small metastatic nodule in the vagina, this structure and the tube being the only organs involved.

**Microscopic.** The histology of this disease is well established and pathologists generally agree on two main types—(1) papillary and (2) papillary alveolar—though various minor modifications of these two patterns are occasionally added. Some authors are of the opinion that the papillary type is original and that the alveolar formation is gradually developed by the fusion of adjacent papillary folds. A few cases (Friedenheim) purely alveolar in character, have been described, but the rarity of this type together with the difference of opinion among authors concerning its origin does not favor its inclusion as a special type.

Except in very early cases it is difficult to reproduce a differential picture of the two main

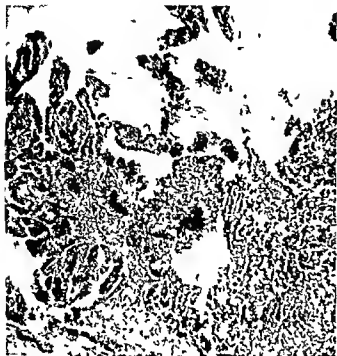


Fig 2 Section through the tumor wall showing the papillary pattern of the proliferating mucous folds. The round cell infiltration present is rather more marked than in most sections

types. With epithelial proliferation the papillae of adjacent mucosal folds intermingle and cohere to form pseudo-alveoli at a very early stage. Many of the affected mucosal folds show marked hypertrophy and arborescent branching consisting of a delicate fibrous tissue core covered with single and multiple layers of cuboidal or low columnar epithelial cells which are irregular in size, shape, and staining reaction. In advanced cases, the mucosal folds and alveolar spaces become distorted as a result of fluid pressure or cellular proliferation or both. The lumen in the solid or semi solid tumors is occupied by medullary masses, separated by sparse fibrous tissue septa, in which areas of hemorrhage and necrosis are often observed. Invasion of the muscularis as well as the tubal lumen is occasionally noted, though penetration of the serosa is uncommon even in advanced cases.

Round cell infiltration and capillary dilatation in the mucosa and submucosal layers are noted in a majority of cases. These findings, in some instances, are confined to the affected portion of the tube and are undoubtedly secondary to the development of the tumor and can in no wise be considered evidences of previous inflammation. In our case the opposite tube and the inner third of the affected tube are free from evidences of inflammation.

The subjacent ovary is frequently involved and almost invariably so when the mass is tubo-ovarian in character. The ovarian metastases are generally in the form of medullary masses which occupy cystic spaces or invade the stroma.

#### SYMPTOMS

There are no characteristic symptoms which in a majority of cases should lead one to suspect a primary tubal malignancy. Vaginal discharge, abdominal pain, and menstrual irregularities are the subjects of common complaint in these women. The discharge, usually watery and clear or straw colored at first, is the nearest approach to a characteristic symptom. It is interesting to note that in the case reported the onset was marked by a bloodtinged watery discharge which, after 5 weeks, became colorless and stainless. The character of the discharge may be modified by infection, necrosis, or hemorrhage at the site of the growth, or by co existing pathology in the uterus and vagina. The discharge may be continuous or intermittent, scanty or profuse, depending probably on the patency of the uterine end of the tube. The discharge in our case was continuous and exceedingly profuse. The intermittent type (also, said to be characteristic of "hydrops tubae profluens" (7), often occurs in periodic gushes and is preceded and sometimes



Fig 3 Section through the tumor wall showing marked hyperplasia of the epithelium covering a mucosal fold. Compare with Figure 2 with regard to round cell infiltration.

accompanied by paroxysmal cramp like pains which gradually subside as the fluid escapes

In addition to the pain previously mentioned pain is generally present in the lower abdomen, usually on the side of the lesion. The pain varies in character and intensity from an occasional dull ache to a frequent sharp shooting exacerbation which very frequently radiates to the back and produces, in some cases, severe sacral backache.

Metrorrhagia is probably the most frequent complaint, but there is nothing typical to distinguish it from bleeding due to uterine pathology. Menorrhagia, dysmenorrhoea, and irregular intervals of amenorrhoea are not uncommon. In evaluating these menstrual alterations the average age of these women must be considered.

Urinary disturbances, gastro intestinal symptoms, general weakness and loss of weight are not uncommon during the later stages of the disease.

#### PHYSICAL SIGNS

There are no physical signs sufficiently characteristic to differentiate tubal malignancy from adnexal disease in general. A tense cystic or solid mass, oval or sausage shaped, varying in size from a few to 15 or 20 centimeters in diameter is generally felt on one or both sides of the uterus or in the cul de sac of Douglas. On the other hand, slight induration in one fornix may be the only finding. When adherent to the ovary the size of the mass will then depend on the condition of that organ. Bjar states that the tube is free nearly as often as it is adherent. Ascites is noted in a small number of cases and does not appear as a



Fig. 5. Section through the tumor wall showing invasion of the muscularis by the tumor cells.

rule until rather late in the disease. Inguinal and supraclavicular lymph nodes are occasionally involved. Anemia and undernourishment are not uncommon, but extreme cachexia is rare.

#### DIAGNOSIS

The insidious onset with signs and symptoms commonly present in various other pelvic conditions makes the diagnosis exceedingly difficult. In only a few instances is cancer of the tube mentioned in pre operative diagnoses. This was based upon the microscopic appearance of tissue obtained by a diagnostic puncture of the cul de sac. Chronic pelvic inflammatory disease, tubo ovarian abscess or cyst, cancer of the ovary or the uterus, and myoma uteri are the conditions commonly recorded in the pre operative diagnoses. If a serous or sanguineous vaginal discharge cannot be accounted for otherwise a diagnostic curettage should be done, and if microscopic examination of the uterine scrapings fails to reveal the source of bleeding, a cancer of the fallopian tube should be considered. Chronic salpingitis, hydrosalpinx or pyosalpinx, and tubo ovarian cyst or abscess are the terms most frequently used to describe the condition at operation. In many instances the cancer would probably have been recognized or at least suspected at the time of operation if upon its removal the tumor had been immediately opened and inspected.

#### TREATMENT

Failure to recognize the disease has resulted in conservative operations in a majority of cases. Upon receipt of the pathological diagnosis a second operation for the removal of the remaining

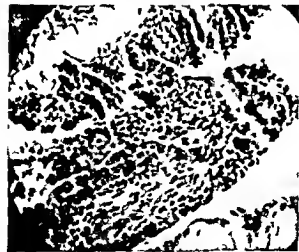


Fig. 4. High power view of lower left corner of Figure 3 showing the polymorphous character of the hyperplastic cells.

internal genitalia has occasionally been done. In many patients the condition was too far advanced for anything but palliative measures. Complete extirpation of the uterus and adnexa via the abdominal route is generally advocated. Some authors believe it is unnecessary to remove the cervix as metastases are rarely found there. Bower and Clark would preserve the cervix for subsequent radium implantation. Excision of all palpable pelvic and retroperitoneal lymph nodes has been advised. This procedure is questionable, since metastasis to the intricate pelvic lymph system permits little hope for a surgical cure. Postoperative, deep roentgen-ray therapy is frequently suggested and is undoubtedly worth a thorough trial. Follow-up records are too inadequate for the drawing of conclusions concerning the best method of therapy in these cases. Available statistics show that the radical removal of the uterus and adnexa has accomplished little, if any, improvement in the prognosis of the disease. Nevertheless, the fact that the disease is bilateral in about one-third of the cases plus the fact that the ovaries and the uterus, though macroscopically normal, may be implanted with the disease are sufficient indications for the radical procedure, despite its apparent failure to alter the prognosis.

#### PROGNOSIS

Based on follow-up records, the operative results are found to be extremely poor. Only 6 patients have survived the third postoperative year without a recurrence. Four of these have passed the 5 year mark without a recurrence.

The case reported below is interesting for the following reasons, (1) it is the only case of primary carcinoma of the fallopian tube on record in the department of pathology at the University of Oregon Medical School, (2) it is one of a minority group of these cancers in which there is no evidence of previous pelvic inflammation, (3) the nearest approach to a characteristic symptom (watery vaginal discharge) was present and exaggerated, (4) the disease was recognized at operation and treated radically, and (5) the disease was confined to the outer half of one fallopian tube and subjacent ovary with no evidence of further extension or metastasis.

#### REPORT OF CASE

Mrs C S., white, aged 50 years, housewife and laundry worker, entered the Multnomah County Hospital, November 8, 1928, complaining of watery vaginal discharge. Patient's mother had died of "stomach trouble" at the age of 61 years. A sister had died following an abdominal operation for "tumor" at the age of 52. Patient had had no severe illnesses and no operations. She had had ten full

term pregnancies without complication. There had been no miscarriages or abortions. The menstrual cycle always normal in every way had ceased abruptly with the last period in October, 1914. During the past 24 months symptoms characteristic of the climacteric had appeared.

The onset of the present illness was 7 months ago was marked by the sudden appearance of a blood tinged watery discharge which stained her clothing. Previous to this she had had no vaginal discharge. The discharge, continuous from the first, had become gradually more profuse and 6 weeks after the onset had lost its staining qualities. During the past 6 weeks napkins (each composed of a folded hundred pound flour sack) had to be changed three or four times during the day and twice during the night. During and following exertion there had been a mild, dull aching pain in the lower quadrants of the abdomen which in the last 6 weeks had become more severe. Sacral backache and sharp shooting pains in the lower abdomen had produced uncomfortable nights for over 2 weeks. She had been able to keep up her work but had suffered from pain and fatigue. Her appetite had been poor for 1 month and she felt that she had lost weight and strength. Slight soreness in the lower right quadrant of the abdomen had been present for 1 week.

Physical examination disclosed firm, moderately movable, tender mass about 6 centimeters in diameter posterior and to the right of the uterus. This mass was slightly adherent in the region of the right utero-sacral ligament. The laboratory reports were irrelevant.

Provisional diagnosis: (1) tubo-ovarian mass, probably inflammatory in character, (2) cancer of the fundus uteri.

A diagnostic curettement revealed nothing suspicious of cancer. The abdomen was opened through a low midline incision. There were no signs of inflammation and no free fluid in the abdomen. The uterus and left adnexa appeared normal. The right fallopian tube was enlarged in its distal half to form an oval tumor about 5 by 6 centimeters in diameter. This was lightly adherent and easily separated from the posterior part of the peritoneum in the region of the right utero-sacral ligament. A small thin walled cyst not connected with the ovary was attached to the closed imbricated extremity of the tube. The cyst ruptured on manipulation and released a small amount of clear serous fluid. The right ovary showed no gross abnormalities and was not connected with the tubal mass. The right adnexa including the previously mentioned cyst, were removed with a wedge of uterine muscle. The tubal mass was opened and revealed a hemorrhagic, friable, papillomatous growth which hid the appearance of cancer. In view of this finding, the entire uterus with the left adnexa was completely removed. No pelvic lymph nodes were felt.

The patient was discharged in excellent condition after a normal convalescence of 14 days. She was advised to return at regular intervals for examination and deep roentgen ray therapy. Hospital records show that on December 14, 1928, she received 250 millimicro minutes of X ray, front and back.

March 10, 1929, 5 months after operation the patient was seen by the writer. She had no complaints and the pelvic examination was irrelevant.

Pathology: The uterus and left adnexa appeared normal. The proximal half of the right tube was normal except for a slight increase in its diameter whereas, the distal half was greatly enlarged to form an oval tumor measuring 3 by 4 by 5 centimeters. The imbricated extremity of the right tube was closed and formed a small cyst not connected with the ovary. An opening in the cyst revealed a smooth interior surface which embraced one of the tubal fimbriae. The serosa of the tube was pale pink, smooth and glistening except for a few small roughened areas due to adhesions. An



opening in the thickened wall of the distal half of the tube revealed a hemorrhagic, friable papillomatous growth which occupied the entire lumen (Fig. 1). When sectioned the proximal half of the tube was found to be patent with no gross evidence of pathological change. The right ovary measured 2.5 by 3.5 centimeters and had a bossed surface which was due to a few small superficial cysts plus several firm elastic nodules. Bisection of the ovary revealed a grayish surface with several small encapsulated compact areas which were non friable.

Sections from the uterus and left adnexa appeared essentially normal. The proximal third of the right tube was normal save for a slight increase in the diameter of its lumen. Sections from the middle third of the right tube 2 centimeter from the tumor showed a slight round cell infiltration and a slight hypertrophy of a few of the mucosal folds. Sections from the tubal wall which encapsulated the growth, revealed a patchy round cell infiltration of all the coats with a definite increase in connective tissue elements and a marked distortion and a hypertrophy of the mucosa. There were few normal mucosal folds. The majority of these were composed of thick, avascular fibrous tissue cores covered with single and multiple layers of epithelial cells (Figs. 2 and 4). Where not distorted by crowding the tumor cells were low columnar or cuboidal in type with cytoplasm that took a light eosin stain and nuclei that were irregular in size, shape and staining reaction (Fig. 3). A few mitotic figures were seen (Fig. 5). In many areas alveolar like masses of cells appeared to have sprung from the mucosa between the papillary folds and to have invaded the wall as well as the lumen. The serosa of the tube was not penetrated by tumor cells. The dense friable central portion of the growth was composed of papillary chains of cells which in areas were so closely placed that the original papillary pattern was almost indistinguishable. In addition there were areas in the tumor without particular pattern which were composed of closely packed large polygonal cells with clear faintly staining cytoplasm and nuclei. Many of these cells were vacuolated and partially disintegrated. The previously noted ovarian nodules had a fibrous capsule which surrounded compact cellular masses. The latter were composed of round, oval and spindle shaped cells with a faintly staining cytoplasm and irregularly shaped nuclei that took a light hematoxylin stain. Hyperchromaticity and mitosis were less common than in the tumor cells of the tube. A few corpora lutea were seen. The greater portion of the ovarian stroma was replaced by the tumor nodules. Invasion of the ovarian capsule by the tumor cells was not noted.

#### CONCLUSIONS

1 Primary carcinoma of the fallopian tube is a rare disease. About 200 authentic cases are recorded in the literature.

2 Age incidence is the same as for cancer in general.

3 The etiology is unknown, though many authors are of the opinion that chronic salpingitis commonly associated with the disease, is a predisposing factor.

4 There are no characteristic physical signs or symptoms. Watery vaginal discharge, blood tinged at times is the nearest approach to a characteristic symptom.

5 The diagnosis has been made only once (by Falk) before operation. In a large percentage of

the cases the disease was neither recognized nor suspected at operation. The case reported demonstrated the value of immediate section and in specimen of extirpated pelvic tumors.

6 Statistics are too inadequate for the drawing of conclusions concerning the best method of therapy. The very nature of the disease, however, indicates a radical extirpation of the uterus and adnexa.

7 The prognosis is poor. Few cases have survived the fifth postoperative year.

8 Macroscopically, the disease resembles a chronic inflammatory condition (often indistinguishable from a pyosalpinx or hydrosalpinx) of one or both tubes. On opening the tube a friable, papillomatous growth is commonly noted.

9 Microscopically, the essential picture is a papillary or papillary alveolar type of tumor. The primary disturbance appears to be a malignant hyperplastic change in the cylindrical epithelium of the tube.

10 The subjacent ovary is frequently involved.

11 Retroperitoneal lymph gland metastases are common.

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## PATHOLOGICAL FRACTURES

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A PATHOLOGICAL fracture may be construed as any fracture occurring through a demonstrable bone lesion and implies a causative stress too trivial to produce the same result in normal bone

In a review of 1,405 cases of fracture of the long bones at the Massachusetts General Hospital during the 10 year period from January, 1910, to January, 1920, there were 24 cases of pathological fracture. Fractures of the type of Potts' and Colles' and those fractures of the clavicle treated as ambulatory cases were not included in the cases reviewed. Of the 24 cases obtained 14 were females and 10 were males, and the ages included ranged from 9 months to 66 years. Table I shows the distribution as to age and sex of these cases and it is interesting to note that of all the long bones the greatest number of pathological fractures involved the femur where, of 560 cases of fracture, 15 were spontaneous and of these the fracture was below the trochanters in 9 instances. One case of fragilitas ossium, not shown on the chart, was a female baby 9 months old with multiple fractures involving all the long bones except the right humerus and clavicle.

The abnormal bone conditions responsible for these fractures and the bones involved are listed in Table II and it is immediately apparent that

TABLE I—DISTRIBUTION AS TO AGE AND SEX

	Femur	Tibia	Fibula	Humerus	Radius and Ulna	Clavicle	Total
Number of fractures	560	142	97	313	205	85	1405
Pathological fractures	15	4	0	3	0	1	23
Sex							
Male	7	3					10
Female	8	1		3		1	13
Age							
Male	17 to 66	52 to 63					
Female	2 to 53	20		11 to 61		42	

Paget's disease and osteomyelitis accounted for almost half the number of fractures.

The patient with hypernephroma and the 2 with metastatic carcinoma died in the hospital from the original condition, while the case of gumma was a woman, aged 42, who had had a slightly tender lump over the clavicle for a year and an X ray picture taken after admission to the hospital showed a fracture of the clavicle, but the patient did not know when it had occurred. Noon reports 2 cases of gumma causing pathological fracture in a series of 5 cases which, however, were all in soldiers. In the three cases of sarcoma, one occurred in a girl of 9 years who fractured the lower end of the right femur in a fall. A high amputation was done and the pathological report showed large spindle cells and giant cells and the diagnosis of sarcoma, made before operation, was confirmed. Four years later she was well, and there was no evidence of further involvement. The 2 other cases were adults, ages 53 and 60, and the outcome is unknown as the patients left the hospital untreated. The diagnosis in these cases was based on the X-ray findings and may be erroneous. Moore calls attention to

TABLE II—BONES INVOLVED

	Male	Female	Femur	Tibia	Humerus	Clavicle	Total Cases
Paget's disease	4	2	4	2	0	0	6
Osteomyelitis	3	2	4	1	0	0	5
Cyst	0	3	1	1	1	0	3
Sarcoma	0	3	3	0	0	0	3
Fragilitas ossium	0	2	1	0	0	0	2
Metastatic carcinoma	2	0	1	0	1	0	2
Syphilis	1	0	1	0	0	0	1
Gumma	0	1	0	0	0	1	1
Hypernephroma	0	1	0	0	1	0	1
Total	10	14	15	4	3	1	23

his experience that bony metastases of all types of malignancy give the same roentgen appearance, thus emphasizing the fallacy of attempting a cellular diagnosis by the roentgenogram.

In 2 of the 3 cases of bone cyst, the patient had had a previous spontaneous fracture in another bone due to cyst and in each instance the fracture was the first indication of the presence of abnormal bone.

In this series of cases the most common causes of pathological fracture were Paget's disease and osteomyelitis with sarcoma and cystic disease next in rank. It is interesting in this regard to compare Esendrach's report of the Cook County Hospital where tabs was most frequently encountered, which led him to advise an examination of the nervous system in all cases of fracture in which manipulation causes little pain.

The average age in these 24 cases was 38.1 years compared to the average age given by Meyerding of 26.7 years. Nine males were over 30 years of age and 5 females were over 30 years of age.

In Rassieur's series of 588 fractures, 5 were pathological and were caused by syphilis or sarcoma. He concluded that spontaneous fracture was usually a sign of impending death.

Very frequently the spontaneous fracture was the first warning that disease of the bone was present and according to Boggs this may also be true in cases of bone metastases. Nevertheless, the fracture, as Ashhurst says, 'is a complication and does not alter the prognosis or the indications for treatment'. Bone graft is not necessary to secure union in non malignant conditions; curettage with proper postoperative fixation may be quite sufficient (12) as non union is not usual after pathological fracture (5). Bands used in the fixation of fractures have been responsible for spontaneous fracture at the site of the band in the experience of one writer (6). In cases of malignancy of the bone, whether primary or metastatic union rarely takes place and death often intervenes before any reparative process begins. This view is supported by many writers and has been tersely set forth by Codman. However, spontaneous fracture due to metastatic carcinoma sometimes unites quickly although the patient succumbs to the malignant disease (9).

A review of the literature on pathological fracture revealed only 18 cases of fracture due to echinococcus cyst, and a new hazard was brought to light as a cause of bone pathology in the use of radium paint by watch dial painters. One girl thus employed had a spontaneous fracture through the upper third of the femur producing extensive crippling (7).

Of the 24 cases of pathological fracture obtained in this series, 3 died in the hospital, 6 were untreated, and 15 were well from 1 to 4 years after leaving the hospital.

### CONCLUSIONS

Pathological fracture is a rather common incident to bone pathology and frequently is the first indication of its presence.

Pathological fracture in non malignant conditions does not make the prognosis unfavorable.

Indications for treatment of the underlying condition which results in fracture are not altered by the fracture.

Cellular diagnosis of bone malignancy by means of the X ray may be erroneous.

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## INDIRECT INGUINAL HERNIA

SOME OBSERVATIONS ON RUSSELL'S THEORY AND TECHNIQUE

IRLDRIK S WETHERELL, M D, F A C S, SYRACUSE, NEW YORK

RUSSELL, in 1925, set surgeons in this country to thinking on the subject of the repair of indirect inguinal hernia. Many did not, and have not to this day, accepted his theory, although his reasoning and conclusions seemed logical and clear. Some men have accepted the theory and are repairing indirect inguinal hernia by the method suggested by him, but with certain modifications. Counsellor, of the Mayo Clinic, for instance, obliterates the sac by twisting, but he fixes the stump by suturing through the muscle layers anterior to the internal ring. He leaves the muscles of the *falx inguinalis* intact, however, as outlined by Russell.

A case, which came to autopsy 6 hours after operation, in which the classical procedure described by Russell was followed, gave us the opportunity of observing just what happens with the stump of the sac.

It is our purpose in this article to show that, if properly done, this operation leaves the parietal peritoneum at the abdominal inguinal (internal inguinal) ring in better condition, so far as prevention of herniation is concerned if one would allow that this was possible, than in a normal abdomen in which complete closure of the tunica vaginalis has occurred at birth. We purpose, also, to sustain Russell's contention by giving an example of a case, which argues in favor of the preformed sac theory. The history of this case will be recognized by all surgeons as the counterpart, in its main aspects, of nearly all cases of indirect, inguinal hernia. We are speaking of indirect hernia and, not in any sense, of direct hernia. This should be kept in mind, because the cause and effect and cure of the two are often confused in the discussion of hernia.

Consider the cases of two newborn infants of equal robustness, with equally well developed skeletal musculature, one with an indirect hernia and the other with no hernia. The abnormality in the former is due to a patent tunica vaginalis. The muscles of the inguinal region are the same in both, and the rings of the canal are of the same size in both. The hernia is there then, or will appear, not because of a muscle defect but because of the presence of a sac lined with glistening endothelium which is ready to receive any of the abdominal contents that may find their way into

it. If, in any way, we are able, in the abdomen with the hernia, to approximate or even better the picture presented at the abdominal inguinal ring of the well infant, then we should be able to expect that the child with the repaired hernia has the same chance of going through life free from an indirect hernia as the other child who has never had a hernia. It has never had one because it has never had a patent tunica. The muscles of the region have not entered into the picture, and it is reasonable to expect, as Russell suggests, that any attempt at their repair is not only wasted effort but may result in actual weakening of the wall because of strangulation of tissue with sutures, and subsequent atrophy, which may lead to a direct hernia. This latter is often spoken of as a recurrence, which it is not.

In the adult with an indirect hernia, the same conditions prevail as in the infant. The potentialities of hernia have been present from birth. A case in point, which is the counterpart of many such cases, is briefly reported.

A man, 38 years old, was driving an automobile. He was forced off the road, and his car hit a culvert. This drove his abdomen very forcibly against the steering wheel. A few days later, I was asked to examine him completely, because of the possibility of future litigation. He complained of a soreness across the lower abdomen. Examination of the right inguinal region showed a slight impulse against the tip of the examining finger when the patient coughed. A small hernia was evidently present, but what is most interesting is that in a matter of 3 weeks the hernia was apparent in the upper part of the scrotum. This, despite the fact that he was taking things easy, resting most of the time. It is much easier to believe that a preformed sac was present, which was waiting to receive abdominal contents at any time that pressure applied above, would force those contents into the sac than that the peritoneum could pouch and stretch downward to the scrotum in 3 weeks because of a weak muscle at the internal ring(3). A repair by Russell's method then, would leave the muscles as they had been during this individual's life up to the time of the accident, but would obliterate any dumping of peritoneum at the internal ring.

If, then, we can so repair the peritoneum that it is the counterpart of that lining a normal wall, we need not be concerned with the various types of muscle plastic work on the inguinal canal. We surely often see a lax, weak, abdominal wall in a poorly nourished individual, which is not the site of an indirect inguinal hernia. Why, then, do we

continue to disturb the normal relations and nourishment of the wall of an inguinal canal of a robust individual with well developed muscles? Here, again, we will say that a direct hernia is a different proposition—something that must always be looked for when a repair of an indirect hernia is being done. One can conceive of a long standing, large hernia of the scrotal type, which has stretched the muscles of the inguinal region to such a thin atrophic state, that more than Russell's technique must be applied. In these cases an operation with fascial sutures, after Galli, would be indicated.

The autopsy finding in the case, which follows, proves beyond doubt that the parietal peritoneum about the internal ring following Russell's technique, will not only be free of any indentation pointing into the inguinal canal but will actually show a cone of tissue pointing superiorly.

In May 1926 a man 47 years old was admitted to the hospital for the repair of a right indirect inguinal hernia. The swelling in the inguinal region was first noticed after he had lifted an unusually heavy mail bag. Russell's technique was followed in the repair. The hernia was of 3 months standing. The man was a hard drinker and unknown to his physicians had been imbibing for several days before his entrance to the hospital. He was given an ethylene anaesthesia. He was very obstreperous while being taken to his room and became quite violent and unruly in his bed. Opium did not control this violence. He then went into a stupor such as is seen in alcoholics following violent delirium tremens. He died 4 hours after the operation. At autopsy the pathologists were unable to find a cause for the death.

The autopsy gave us the opportunity of examining, within a few hours, the appearance of the peritoneum, which had been crushed and tied at the base of the hernial sac. We expected to find a slight dimpling downward into the inguinal canal, but, to our surprise, there was an actual "upward coning" of the stump. The left side, at the internal ring, showed a normal closure of the tunica vaginalis. This "upward coning" occurs, undoubtedly, as a result of the elastic recoil of the peritoneum, when the stump of the twisted sac is severed.

It seems to us then, if this is what happens—and it does, if all preperitoneal fat is well cleaned from the sac and the sac twisted, until there is an elastic pull from the peritoneum above, before the neck is crushed, tied, and cut—it is needless to transplant the stump into the anterior abdominal wall. In fact, it would seem that this procedure merely prevents the "upward coning" of the stump. This "upward coning" seems to us to be a desirability. It surely eliminates all dimpling toward the canal.

It has been easy for us (6) to follow the procedure, outlined by Russell, in children, but it is surely difficult to break away from the older methods in adults. We have had no recurrences in infants or adults in this type of operation. Counselor has followed the method for the past year with good results. In a recent personal communication (1) one of our prominent surgeons in hernia work states that he is ready to try Russell's technique in a large series of cases.

#### CONCLUSIONS

- 1 When properly done, the peritoneum at the internal inguinal ring presents an "upward coning," thus eliminating completely the entire hernial sac.
- 2 Illumination of the sac is the thing for which the surgeon should strive.
- 3 Muscle transplanting operations are not necessary in indirect, inguinal hernia of recent origin or of moderate size in adults.
- 4 Russell's technique is ideal in infants with indirect inguinal hernia.
- 5 Careful study of the clinical history and physical findings in cases of indirect inguinal hernia, tend to prove the theory of a preformed sac as the potential cause of hernia.
- 6 The interesting details of Russell's technique should be carefully studied, in his articles before attempting the operation.
- 7 An examination for the presence of a direct hernia must always be made, when a repair of an indirect hernia is being done. Repair of such a defect will eliminate many so-called "recurrences."
- 8 When there is practical destruction of the walls of the inguinal canal because of the presence of a long standing, large, indirect hernia, an operation of the Galli type is indicated (4).

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# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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JULY, 1930

## EVALUATION OF STATISTICS

THE use of statistics in support of methods of treatment of disease is essential. Statistics should represent facts, but occasionally they do not, because of incomplete or insufficient data, omission of data not in agreement with the argument, or unjustifiable conclusions. These faults are avoidable. The difficulty of compiling accurate statistics often is due to inherent difficulties in ascertaining the truth, and it is for this reason chiefly that statistical studies of the results of therapeutic measures frequently are so confusing that the reader finds himself confronted with the necessity of evaluating the statistics rather than the questions they are supposed to solve.

In no field of surgery are these facts concerning statistics more apparent than in the benign lesions of the stomach and duodenum. The difficulty of estimating the effectiveness of surgical treatment of any lesion that is characterized by dyspepsia is obvious, and the ease with which the unfavorable results of any specific method may be assembled is often too readily made use of by advocates of

some other method. Any therapeutic principle must rest on its merits rather than on the demerits of other principles of treatment. The practice of emphasizing the failures which may follow any surgical treatment for peptic ulcer in an attempt to substantiate one treatment for all cases has tended to submerge the fundamental principle in the surgical treatment of peptic ulcer, namely, the selection of the best method to be followed in the individual case.

It is refreshing therefore, to find in a collective investigation under the direction of Arthur P. Luff and under the auspices of the British Medical Association<sup>1</sup> a compilation of statistics on the results of the surgical treatment of duodenal ulcer which is convincing because it is a sincere effort to assemble facts rather than opinions. It is particularly convincing since it is a report of a large number of cases in which operation has been done by 86 surgeons in Great Britain. The fact that the results are not the experience of an individual is most significant and should be remembered when comparison is made with the results reported by those advocating particular methods.

The outstanding facts included in this report are concerned with those points about which there has been much debate. The first is that in about 1,500 cases of lesions of the duodenum or of lesions encroaching on the pylorus from the duodenum, and in which operation was performed, an indirect operation, gastro-enterostomy, was used in more

<sup>1</sup>Luff A. P. The after history of gastro-enterostomy. Part I Brit M J 1929 ii 1074-1075. Part II Brit M J 1929 ii 1125-1129. Editorial. End results of operation for gastric and duodenal ulcer. Brit M J 1929 ii 1066-1067.

than 95 per cent, and partial gastrectomy in about 2 per cent. British surgeons with few exceptions, advocate conservative surgical procedures in duodenal lesions, and this report considered from any angle, amply justifies the practice. The report shows, for example, that in 90 per cent of the cases in which gastroenterostomy was done, satisfactory results were obtained, the average time at which the results were evaluated was 7 years after operation. Gastrojejunal ulceration occurred in 2.7 per cent of the cases in which the lesions were classified as duodenal, and in 0.9 per cent of those in which they were classified as pyloric. Subsequent hemorrhage was reported in 2.4 per cent in the group of duodenal lesions and in 1.2 per cent in the group of pyloric lesions. As might be expected, carcinoma did not develop in any of the cases of duodenal lesions, and since there was none in the group of pyloric ulcers the fact is substantiated that the lesions in the latter group were primarily duodenal. Experience has shown conclusively that lesions which extend on the gastric side of the pylorus may be carcinomatous at the time of operation or they may later become malignant and that following indirect procedures alone in a sufficient number of such cases, death from carcinoma will occur in a certain number of instances.

All in all, the report is most impressive in its simplicity and in its adherence to facts, and it should do much to remove any doubt from the minds of those who may still be uncertain as to the value of adopting conservative measures in the surgical treatment of cases of duodenal ulcer. National medical associations may find in the report a suggestion of value as to the carrying out of similar investigations in the same impartial way.

DONALD C. BALFOUR

## RECURRENT AND PERSISTENT HYPERTHYROIDISM

IT is now generally accepted that the removal of sufficient hyperplastic thyroid tissue will relieve a patient of hyperthyroidism. If, however, there is a recurrence or a persistence of the hyperthyroidism after thyroidectomy, there is a very general tendency to postpone too long any secondary operation upon the thyroid gland.

Failure to relieve so called thyroid toxicity by thyroidectomy may be due to the fact that hyperthyroidism was never present and the operation was performed with an erroneous diagnosis. Such a case must be distinguished carefully from true persistent hyperthyroidism and every effort made to treat the real cause of the symptoms. When, in questionable hyperthyroidism, the primary removal of a large amount of thyroid tissue fails to produce marked relief of symptoms, the diagnosis of hyperthyroidism should be strongly suspected of being wrong. Probably true hyperthyroidism was never present and further surgery should be either long delayed or entirely avoided.

True recurrence of hyperthyroidism occurs when, after an interval of twelve months or more with a normal basal metabolic rate and freedom from symptoms following thyroidectomy, the basal metabolic rate is again elevated and symptoms of thyroid toxicity reappear. True recurrences are quite rare but do occasionally occur.

Persistent hyperthyroidism, on the other hand, is said to be present after thyroidectomy if the basal metabolic rate fails to return to normal and the symptoms of hyperthyroidism never entirely disappear. Persistent hyperthyroidism is not uncommon and is the usual finding in cases of exophthalmic goiter not relieved by operation.

Recurrent hyperthyroidism should be treated as though no previous operation upon the thyroid had been performed. After proper preparation with rest and Lugol's solution, secondary thyroidectomy, with the thorough removal of all excess hyperplastic tissue, is undertaken. These measures will bring relief in the vast majority of cases. The possibility of further recurrence is slight.

In persistent hyperthyroidism, however, when the basal metabolism has failed to return completely to normal after thyroidectomy and symptoms of toxicity persist, palliative measures may for a time be adopted. In certain patients, limitation of activities and the daily use of Lugol's solution will permit so comfortable and safe an existence that surgery can be, at least temporarily, delayed.

Usually, however, these measures fail and when after a fair trial the basal metabolism remains elevated and complete relief of the hyperthyroidism is not obtained immediate secondary thyroidectomy should be advised without further delay. Prolonged temporizing with definite persistent hyperthyroidism should be avoided just as rigidly as in primary hyperthyroidism since long standing hyperthyroidism carries with it so many undesirable complications. Secondary thyroidectomy in persistent hyperthyroidism cases gives most satisfactory results when it removes completely the excess hyperplastic tissue. It should be urged when it is obvious that the primary operation has failed to relieve the patient of hyperthyroidism.

HOWARD M. CLUTE



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All in all, the report is most impressive in its simplicity and in its adherence to facts, and it should do much to remove any doubt from the minds of those who may still be uncertain as to the value of adopting conservative measures in the surgical treatment of cases of duodenal ulcer. National medical associations may find in the report a suggestion of value as to the carrying out of similar investigations in the same impartial way.

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FRANCIS J SHEPHERD  
1851-1929



In 1883, he was elected full surgeon to the Montreal General Hospital and organized a course of summer clinics for students who remained in Montreal during the summer months. These clinics were very popular and much appreciated.

While in Vienna, Dr. Shepherd took a special course in dermatology under Hebra, and on his return started a department of dermatology in the Montreal General Hospital. His interest in the subject continued to the end. In 1907 he was named vice-president of the Dermatological Congress held in New York and in 1928 was made president of the Canadian Branch of the British Dermatological Society.

Dr. Shepherd's surgical work merits the highest praise. He was a most careful diagnostician, and his operative work was bold and progressive yet at the same time conservative. He was particularly interested in the development of the surgery of the thyroid. I was intimately associated with him for many years and always found his opinion sound. Under his teaching in the old summer sessions many young men received a training in surgery at the beginning of their career that left an impress that was never lost. Always careful, the interest of his patient was ever foremost in his mind.

Dr. Shepherd's work in anatomy, dermatology, and surgery was appreciated outside his native land. In 1913, he was chosen to act as vice president of the department of surgery at the International Medical Congress in London. He received an honorary fellowship from the Royal College of Surgeons, Edinburgh, and had the degree of doctor of laws conferred upon him by the University. He also received the much prized honor of the honorary fellowship of the Royal College of Surgeons of England. The degree of doctor of laws was conferred upon him by Harvard University in 1906, by McGill in 1915, and by Queens in 1919. He was also made an honorary fellow of the American College of Surgeons. He was elected corresponding member of the Societe Internationale de Chirurgie of Paris, and foreign member of the American Academy of Arts and Sciences.

In 1924, his numerous friends in the profession presented him with a portrait of himself, by Miss Des Clayes. This now hangs in the large hall of the medical building of McGill University along with the portraits of previous deans. He was dean of the Medical Faculty 1908-1914, president of the Medico Chirurgical Society in 1894, and president of the Canadian Medical Association in 1901.

Dr. Shepherd contributed liberally to medical literature. In addition to his *Surgical Retrospect* already mentioned, he was joint author of *American Textbook of Surgery*, author of the article "The Thyroid" in the *American Practice of Surgery*. He contributed to the *Annals of Surgery*, *Journal of Anatomy and Physiology*, *Canadian Medical and Surgical Journal*, *British Medical Journal*, and *Lancet*.

Dr. Shepherd had many outside interests. He was fond of nature and fishing, and had a lovely country home at Como on the Ottawa river where he entertained

his friends in royal fashion. He was particularly fond of art, especially of oil painting, and indeed was regarded as an authoritative critic. He was president of the Montreal Art Association from 1906 to 1910, and in 1918 he was again persuaded to take that position which he was still occupying at the time of his death. On the occasion of his seventy-seventh birthday, he was presented with a bronze bust of himself by a circle of his friends in the association.

For many years he was a member of the Board of Trustees of the National Gallery at Ottawa and recently chairman of the board. He was keenly alive to the value to the country of collections of fine art, not only for educational purposes but for the increase of national pride in art and a stimulus to all who may be able to enrich their country with further valuable examples.

The public will remember Dr. Shepherd's achievements, his patients will remember him as a kindly and skilled physician and surgeon, his associates and friends will cherish the remembrance of his character. He was frank, outspoken, versatile, and a man of unimpeachable integrity. Dr. Shepherd was a widower for many years. He had one son, whom he lost in the war, and two daughters—Mrs. Nobbs, and Miss Dorothy—who devoted her life to the care of her father.

On January 17, 1929, he was at his club and in a particularly happy mood. The following morning when his breakfast was taken in to his room he seemed cheerful as usual. When a little later the servant returned to take away the tray, she found him sitting up in bed, his spectacles on, the morning paper in his hand, but he had passed on.

GEORGE E. ARMSTRONG



# ZACVTI LVSITANI,

Medici, & Philosophi præstantissimi,

OPERV<sup>M</sup> TOMVS PRIMVS,

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PRINCIPVM HISTORIA.

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occurrunt, concisè ordine disponuntur Paraphrasi & Commentariis  
Illustrantur periculis Quæstionibus Dubiis & Observationibus  
et quilibet exornatur*

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### THE COLLECTED WORKS OF ZACUTUS LUSITANUS

**A**BRAMHAM ZACUTUS, more commonly known as Zacutus Lusitanus, was a Portuguese Jew who was born at Lisbon in the year 1575. The descendant of an old Jewish family, he was given the opportunity to obtain an excellent education. He studied at the Universities of Salamanca and Coimbra and not until 19 years later at Segueza, a town in the province of Segovia, was he given his doctor's degree. He practiced in Lisbon for 30 years and after building up a magnificent practice and making an excellent reputation, he suffered with the rest of the Jews in Portugal, from the order of banishment which was proclaimed in 1625 by King Philip IV. Zacutus left Portugal and went to Amsterdam where he spent the rest of his life in practice and died in 1642. These facts are given in the history of his life which is contained in the first volume of his collected work, written by Ludovicus Lemosius of Lisbon who was physician in ordinary to the Royal Court.

Daremberg, writing in 1870, makes the statement concerning Zacutus' work that it is "a work which is still very useful." It seems to me that this same statement holds true today, and I do not believe that the book can be summed up better than it is summed up on the title page of the first volume which says "Where all the medical histories of internal disease which are met with here and there among the principal medical men are arranged in proper order and are illustrated with paraphrases and commentaries, and also are adorned most exquisitely with questions, criticisms and observations." Zacutus has searched the literature up to his time, not neglecting the literature of his contemporaries, and taken all internal diseases, and some external, and arranged them in order from the head to the foot, most of his case histories being drawn from Galen and the Arabian physicians.

He arranges the matter in the following form. First comes the history of the case as it is given in Galen, or one of the Arabian authors. This is usually copied directly from the book as published. Then he takes up a discussion of the disease in question which he calls a paraphrase. Then if he has had a similar case himself, he gives the history of his own case or one that he has seen with some other physician and gives the result of the treatment and where it may or may not differ from the idea of the old

author. When speaking of his own case he usually refers to the ideas of his contemporaries. For instance, in his first observation concerning alopecia he says he cured a case of baldness with the juice of nicotiana which he says is vulgarly called tobacco. He then quotes a book, *The Book Concerning Tobacco* by Joannes Meander Bremanus. Where there are certain things of which he is doubtful he asks a rhetorical question and then discusses the question he has asked and usually decides in his own favor.

Zacutus himself, apparently did not practice surgery, and when a case fell into the surgical class, called for a surgeon to do the operative work. Many of the cases scattered through the two volumes, however, are surgical and many of them are of exceeding interest. The forty-ninth observation of the third book is of extreme interest. Zacutus gives the history of a case which he entitles "A stone springing above the frenum of the tongue." He says that a certain noble was bothered with a catarrhal fluxion which appeared in the external part of the tongue next to the frenum and caused a rather large painful tumor which almost made him lose his voice. A surgeon was called who washed it lightly with emollients and took council and then made an incision. A stone showed itself surrounded by yellow pus. It was hard, on the left side, and about the size of a filbert. It was then extracted with a vulsellum and the tumor disappeared. The wound healed safely and the patient was brought to perfect health. He then goes back in medical literature and quotes a case of stone in the tongue described by Avenzoar in his second book. Following this he gives a criticism and asks whether stones may form in various parts of the human body. This again is followed by a commentary, or discussion, regarding the formation of stones all over the body. Nearly all of the common surgical diseases are considered and many of the uncommon.

Zacutus had evidently read nearly all of the works of the ancient authors and also those of his more recent predecessors and even of his contemporaries. He shows himself to be an exceedingly clear and careful observer and, even though of necessity, his histories are reduced to small space and are not complete as we would consider completeness in a medical history today, nevertheless they are so plainly stated and the arguments so clearly carried out that in nearly every case it is possible to make a diagnosis of the condition found.



## REVIEWS OF NEW BOOKS

VOLUMES III and IV continue the exhaustive German handbook<sup>1</sup> on urology. Like all such systems the quality of the chapters varies with the author. With one or two exceptions the classification is on clinical lines which results in some repetition which might have been avoided if the exposition had been based on pathological entities. In most of the articles extensive references to the literature are given, but as German authors do not have the assistance of our splendid medical indices of literature, they do not adhere to any special method of giving the references, with the result that not a few of them are incomplete and very difficult to find.

Anomalies are first considered. It is interesting to note that they have been divided into separate anatomical and clinical portions written by different authors. The section on malformations of the male sex organs is unusually good and contains much material hitherto unfamiliar to many. The clinical sections on malformations has a long study of the literature without the critical attitude one would hope for. The chapter on injuries contains much interesting war material. A chapter on diseases of micturition and one on nervous diseases of the bladder contains no mention of the splendid work of the English physiologists. To discuss nephritis a subject usually more or less excluded from American works on urology. 116 pages are devoted.

The surgical treatment of nephritis and eclampsia is completely covered. It is especially interesting that neither Heschner nor Voelcker recommends pyelography as an important diagnostic aid in renal carbuncle or renal tumor. Ureteral dilatation is not mentioned as a part of the treatment of renal infections. There is no reference to submucous fibrosis or Hunner ulcer of the bladder. In the treatment of gonorrhea also no stress is laid on urethral dilatation but it is mentioned only as one of the procedures with which to determine a cure. Renal tuberculosis is covered in an authoritative style by Wildbolz but tuberculosis of the genital tract is done in much more academic fashion. Rosenstein presents an excellent monograph on actinomycosis.

The masterpiece of the two volumes however, is the long chapter on renal stone by Gottstein. He covers every aspect of this subject in a masterly way, omitting only the latest studies on the effects of diet and vitamins on stone formation. Horskens makes some very sensible remarks concerning movable kidney. One of these deserves quotation namely, "Never do nephropeky in cases of general enteroposis or where there is a definite psychoneurosis." Hottinger in treating of bladder stone gives as much

space to perineal lithotomy as to suprapubic. This is in contrast to the American practice. Voelcker and Boeminghaus used the term hypernephroid tumor instead of hypernephroma which is certainly a step in the right direction. Curiously enough echinococcus cyst is included in the chapter on solid tumors of the kidney.

The reviewer did not note any reference to the phenolsulphonethylamine test in the two volumes and only a few to the indigocarmine test. Apparently much stress is laid on the freezing point of the urine.

This work contains much of great value and it is extremely instructive as illustrating the practice of some of the masters of urology in Germany. The reviewer feels however that it would be a mistake for any American urologist to take it as his sole text book.

DWM M. DAVIS

SIX years have elapsed since the first edition of Starr's excellent monograph<sup>2</sup> on local anesthesia. The thoroughly revised second edition is much more than a lucid presentation of this subject. It is really a book on surgical technique admirably adapted to the requirements of local anesthesia.

The psychic factors, the physical comfort the posture on the operating table, a special injector, the wire spring retractors, and other ingenious devices, which had previously been described by the author all serve one purpose—smooth and successful teamwork and a surgical strategy, "without which even the most skillful 'nerve block' gives only half results." It may be argued, that the average surgeon can perform operations under local anesthesia with less technical equipment but the authors' simple, practical methods of infiltration are easy to follow and are always successful.

One cannot help but admire a whole life's work as represented in this volume which is dedicated to the comfort of that "unfortunate individual, the patient who fate has decreed must undergo surgical treatment." The illustrations and the printing are excellent.

GEZA DE TAKATY

A COMMITTEE appointed by the American Gynecological Society has prepared a *Syllabus of Lectures on Obstetrics for Nurses*<sup>3</sup> which is now ready for distribution to those interested in the subject of nurse training. Copies may be obtained from the chairman of the committee at the nominal price of 50 cents by addressing a request to 23 East 93rd Street, New York, New York.

<sup>1</sup> *HANDBUCH DER UROLOGIE*. Edited by A. von Lichtenberg. F. Voelcker H. Wildbolz. Vols. III and IV. Special Urology I and II. Berlin Julius Springer 1927.

<sup>2</sup> *PRACTICAL LOCAL ANESTHESIA AND ITS SURGICAL TECHNIC*. By Robert L. Starr. FARR AND FARR'S and ed. Third Edition. Lea and Febiger 1929.

<sup>3</sup> *A SYLLABUS OF LECTURES ON OBSTETRICS FOR NURSES*.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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## PLANS FOR THE 1930 CLINICAL CONGRESS IN PHILADELPHIA

THE clinicians of Philadelphia are interested to provide a complete showing of the clinical surgical activities of that great medical center during the twentieth annual Clinical Congress of the American College of Surgeons to be held in that city October 13-17. They are preparing a program of clinics and demonstrations to be given in the hospitals and medical schools of that city that will include all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, and surgery of the eye, ear, nose and throat. Clinics are scheduled to begin at 2 o'clock on Monday, October 13, and for the mornings and afternoons of the following four days. A preliminary clinical program will be published in the August issue of this journal. Recalling the splendid programs presented at four previous sessions in this city one may confidently assume that this year's Congress will surpass all previous efforts in point of scientific interest.

A series of fracture clinics demonstrating modern methods in the treatment of fractures will form a special feature of the clinical program. At many of the larger hospitals plans are being made for a comprehensive showing of methods employed and results obtained in the treatment of fractures which forms so large a part of the surgical work in large cities and industrial centers.

A subcommittee composed of William T Shoemaker, Chairman, J A Babbitt, Louis H Clerf, Fielding O Lewis and Luther Peter has been appointed to arrange programs for a series of clinical demonstrations on ophthalmological and oto-

laryngological subjects to be held at headquarters each morning except Monday, in view of the fact that the clinical work in these specialties will be demonstrated at the hospitals in the afternoons.

The Executive Committee of the Congress is preparing programs for a series of five evening meetings. On Monday evening at the Presidential Meeting the president-elect, Dr C Jeff Miller of New Orleans, will be inaugurated and will deliver the annual address. Another feature of that meeting will be the annual Murphy oration in surgery. Distinguished surgeons of the United States and Canada, and eminent surgeons from abroad have been invited to present papers dealing with surgical subjects of present day importance at scientific meetings on Tuesday, Wednesday and Thursday evenings. On Friday evening at the annual Convocation of the College, the 1930 class of candidates for fellowship in the College will be received.

An interesting feature of this year's Congress will be the showing of a number of surgical films that have been produced under the supervision of and approved by the Board on Medical Motion Picture Films. A number of these films have been completed since the Congress in Chicago last year and such films will be given their premier showing in Philadelphia. An extensive program, to include other outstanding contributions not comprised in the College library of films, is planned.

At the annual meeting of the College on Thursday afternoon, beginning at 2 o'clock, formal reports on the activities of the College will be

presented by the officers and several standing committees. The major portion of the afternoon will be devoted to a symposium on cancer, dealing with various aspects of this important problem.

In addition to the Executive Committee as listed above, the following representatives of hospitals and medical schools have been appointed as members of the Committee on Arrangements: E. G. Alexander, Leon T. Ashcraft, W. Wayne Babcock, William Bates, John A. Brooke, H. P. Brown, Ralph Butler, B. I. Buzby, G. M. Dorance, L. D. Englerth, Ralph Goldsmith, J. Milton Gnscom, Robert Kimbrough, Edward J. Klopp, A. D. Kurtz, Benjamin Lipschutz, Clifford Lull, P. A. McCarthy, J. J. A. McMullin, George M. Marshall, George H. Meeker, William I. Parke, William N. Parkinson, Ross V. Patterson, William Pepper, William Pierson, Warren Reese, Desiderio Roman, Thomas J. Ryan, William Sheehan, Calvin Smyth, John Spiese, Margaret Sturgis, William B. Swartley, Roscoe Tearn, T. Turner, Thomas Martha Tracy, Stephen I. Tracy, Frank White.

An interesting program of papers, round table conferences and practical demonstrations dealing with the problems related to the hospital standardization program of the College and hospital efficiency in general is being prepared for the annual hospital conference which opens at 10 o'clock on Monday morning in the grand ballroom of the Bellevue Stratford Hotel. The conference will continue Monday afternoon and on Tuesday and Wednesday morning and afternoon. The program is planned to interest surgeons, hospital trustees, executives and nurses and an invitation to attend is extended to all persons interested in the hospital field.

General headquarters for the Clinical Congress will be established at the Bellevue Stratford Hotel located at the corner of Broad and Walnut Streets. All of the rooms on the second floor, including the grand ballroom which will be used for the evening scientific meetings, hospital conference on Monday, the annual meeting and other large gatherings, together with additional rooms on the roof, have been reserved for the use of the Congress and will be utilized for scientific meetings, conferences, film exhibitions, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc.

An application for reduced railroad fares on account of the Congress in Philadelphia is pending before the railway passenger associations and it seems assured that a rate of one and one-half the regular first class one way fare will be in effect from all points in the United States and Canada.

#### PHILADELPHIA HOTELS AND THEIR RATES

The following hotels are recommended by the Committee on Arrangements

	Minimum Rates Single Room	with Bath Double Room
Adelphi 13th and Chestnut Sts	\$ 4.00	\$ 7.00
Barclay Rittenhouse Square East	6.00	8.00
Bartram 33rd and Chestnut Sts		8.00
Belgrave 1811 Chestnut St	4.00	7.00
Bellevue Stratford Broad and Walnut	5.00	7.00
Benjamin Franklin 9th and Chestnut	4.00	7.00
Colonial 11th and Spruce Sts	4.00	7.00
Drake 1512 Spruce St	5.00	8.00
Ellis Broad and Vine Sts	2.50	5.00
Cladstone 11th and Pine Sts	4.00	7.00
Green 8th and Chestnut Sts	3.00	4.50
Lorraine Broad and Fairmount Ave	5.00	9.00
Mandstone 1327 Spruce St	3.00	5.00
Majestic Broad and Cedar Ave	4.00	6.00
Mayfair Lincoln Drive and Johnson St	5.00	8.00
Pennsylvania 30th and Chestnut Sts	3.00	5.00
Rittenhouse 22nd and Chestnut Sts	3.00	5.00
Ritz Carlton Broad and Walnut Sts	6.00	10.00
Robert Morris 17th and Arch Sts	3.50	5.00
St. James 13th and Walnut Sts	3.50	5.00
Stephen Girard 2027 Chestnut St	3.00	5.00
Sylvania Juniper and Locust Sts	4.00	8.00
Tracy 36th above Chestnut St	3.00	5.00
Walton Broad and Locust Sts	3.50	5.00
Warwick 17th and Locust Sts	5.00	8.00
Wellington 10th and Walnut Sts	5.00	6.00
Westbury 15th and Spruce Sts	3.00	10.00

#### LIMITED ATTENDANCE—ADVANCE REGISTRATION

Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets. This plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the Annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## OSTEOCHONDRIITIS OF THE GROWTH CENTERS

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THE purposes of this paper are (1) to assemble a review of the literature concerning a disease common to all the centers of ossification of the human skeleton, (2) to simplify and standardize the terminology of this disease, and (3) to present its occurrence in a family of four individuals.

The literature on this subject is voluminous and confusing. Since the first report in 1903 (Osgood), there has appeared a bibliography of about seven hundred articles. The existing muddle has largely resulted from three major causes: (1) failure to recognize the etiological factor producing the disease, (2) the multiplicity of terms used to describe the same type of pathology in the various ossification centers of the body, and (3) a paucity of pathological material for study.

A review of the literature concerning this subject impresses one with the great variety of terms used to describe what is apparently the same disease. In no other disease of bone is there such a plethora of terminology. If this subject is so perplexing to one who has grown up with the literature, imagine what a difficult situation it must be for the medical student who attempts an understanding of the disease. It is unfortunate that through either indifference or vanity, physicians have allowed their names to be used as diagnostic terms in the various locations throughout the skeleton where this condition occurs. This has resulted in an irregularity of ter-

minology which has added much confusion to that which always occurs when etiology is unknown.

The term "epiphysis" is derived from the Greek word *ἐπιφύσις*, meaning one that grows to another. It is said to have been a familiar word to Hippocrates. Various authors, including Realdus Columbus (1559), Morgagni, Ambrose Pare, and many others, wrote of epiphyseal separation. John Hunter was the first to prove experimentally that long bones grow in length from the epiphyses. John Poland's book, *Traumatic Separation of the Epiphyses*, published in 1898, was probably the most thorough discussion of the subject known at that time. In many ways it has not been improved upon even to the present, although modern X-ray equipment has yielded important additional observations. The earlier writers were concerned chiefly with traumatic separation of the epiphyses. The paper by Osgood in 1903, concerning the tubercle of the tibia, was the first attempt to describe a non-traumatic type of epiphyseal disease. Schlatter gave an account of the same condition in 1908. Koehler (1908) wrote of changes in the tarsal scaphoid and patella. Several years later (1910) Legg, Calvé, and Perthes described a similar disease involving the epiphysis of the head of the femur. Sever also described the same process in the os calcis in 1912 and Freiberg drew attention to it in the head of the second metatarsal in 1914.

Finally, in 1921, Scheuermann reported a similar condition in the epiphyses of the vertebra.

Gradually it became apparent that all these conditions, known by the names of the authors describing them, were very closely related. The custom of applying authors' names to the disease, rather than thinking of it as a pathological entity which might involve any growing ossification center, undoubtedly masked for a long time the fact that all of these lesions were the same process showing similar characteristics in their onset and progress. Thus the disease entity, osteochondritis, was but slowly recognized.

#### ANATOMICAL CONSIDERATION

When the surgeon is called upon for his opinion respecting the nature of injuries occurring in the vicinity of the larger joints in early life he will find a knowledge of the anatomy of the epiphyses of the greatest importance. (Professor R. W. Smith.)

In the majority of cases bone is made of cartilage formed in mesodermal tissue. The first step is a closer aggregation of the mesodermal cells in the location where the model of the bone is to be made. This aggregation of cells assumes an appearance intermediate between fibrous tissue and cartilage, forming a substance called procartilage, which is gradually transformed into hyaline cartilage.

The process of ossification commences at different dates in different bones, but the date is fairly constant for any one bone in different subjects. By the second month of intra-uterine life, ossification has started in nearly all the bones. The point in the bone where ossification begins is called a center of ossification and the center is said to appear at such and such a date. Many of the bones are ossified from more than one center. When a bone has several centers of ossification and the centers appear at widely separated dates, the first to appear is called the primary center and the others are called secondary centers. The largest part of the bone is ossified from the primary center.

Some short bones and some flat bones are ossified entirely from the primary center of ossification, for example, the cubical bones of the wrist and ankle except the calcaneus and rarely the accessory scaphoid. All the long

bones and many others acquire secondary centers of ossification that appear in outlying cartilaginous parts into which ossification from the primary center has not had time to extend. Nearly all the secondary centers appear after birth and the method of ossification from them is the same as from the primary center. Many of the secondary centers do not appear until later, many appear near the time of puberty, for example, in the spine, tibial tubercle, pelvic girdle, ribs, clavicle, and rarely the patella.

The part of a bone ossified from the primary center is called the diaphysis, the part ossified from the secondary is called an epiphysis.

Every long bone has an epiphysis at one end, most of them have epiphyses at both ends. In some bones there are more than one epiphyses at the end, for example, the distal end of the humerus and the proximal end of the femur. Metacarpals, metatarsals, phalanges of feet and hands, as well as clavicle, are examples of bones with epiphyses at one end. In case the larger epiphyses are ossified from more than one center, the parts ossified from these separate centers coalesce before union with the diaphysis, for example, the proximal end of the humerus. When there are more than one epiphyseal centers at the end of bone and the parts ossified from these centers do not coalesce but join the shafts separately, each part is called an epiphysis, for example, the parts at the proximal end of the femur.

It is to be remembered as Poland points out that

the boundary line between the epiphysis and diaphysis alters its relationship very considerably with regard both to those parts to the neighboring joint and to other surrounding structures. Marked examples of this may be seen at the lower end of the humerus and the upper end of the femur. In the latter the whole upper extremity in infancy comprises the head, neck, and greater and lesser trochanters in one cartilaginous mass, but as age advances, the head and trochanters form separate epiphyses by the upward growth of the neck from the diaphysis.

Not only do the individual epiphyses alter their relationship with the corresponding diaphyses during the different stages of their development but the same epiphysis will have a very different anatomical appearance at different periods—e.g. during infancy and during adolescence—at one time forming a relatively large portion of the end of the bone, and

at another time forming a small one, as at the upper end of the humerus

The epiphyses of the long bones in children do not comprise the whole of the end of the bone as seen in the adult, but only about two thirds, the remaining third (e.g., the lower end of the humerus) being formed by the diaphysis (Cruveilhier)

The epiphyses, when fully formed, are somewhat similar in structure to the short bones of the body, being composed of spongy cancellous tissue, arranged in a definite and distinct mechanical manner and surrounded by a thin layer of compact bone. Their diaphysal surface is not smooth but covered with small mammillary projections and pits which accurately fit corresponding depressions and ridges on the end of the diaphysis, strengthening the union between the epiphysis and diaphysis. On the diaphysal ends of some of the long bones, as at the lower end of the tibia, these ridges and elevations are arranged in a very definite manner.

The epiphyses at the two ends of the diaphysis of the long bones at the period of maturity freely communicate by means of openings into the medullary canal, the alveoli of the spongy epiphysal tissue at this period passing into those of the diaphysis.

It is only in rickets and some other pathological conditions that the cartilaginous line is penetrated by blood vessels, the epiphysal cartilage, small though it may be, will in the normal state completely shut off the alveolar spaces of the epiphysis from those of the diaphysis.

The epiphyses obtain their blood supply from the periosteal network of arteries, large branches of which perforate the thin layer of compact tissue on their exterior, and are distributed throughout the spongy cancellous tissue. Nearly the whole of the blood supply is therefore independent of the diaphysis. Only one or two minute arteries pass into the epiphyses from the diaphyses through the conjugal cartilage. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis in traumatic separation of the epiphysis even when the diaphysis is more or less completely displaced from off the epiphysis.

#### CLASSIFICATION AND TERMINOLOGY

We would classify the types of osteochondritis under discussion into either the primary or secondary groups, depending upon whether the primary center of ossification or the secondary center is first involved. The time of appearance and ossification of these centers is represented in the diagrams (Fig. 1). Osteochondritis develops in ossification centers during the period of growth from one or both centers. This classification immediately places all the cubical bones of the wrist and the feet, except the calcaneus, into the primary group (Table I). In the spine both the primary and

TABLE I—OSTEOCHONDRITIS OF THE GROWTH CENTERS

A Primary osteochondritis (involvement of primary centers of ossification)	
1	Spine (before puberty)*
2	Patella (before puberty)*
3	Ribs (before puberty)*
4	Clavicle (before puberty)*
5	Pelvic girdle (before puberty)*
6	Cubical bones of ankle, except calcaneus and rarely accessory scaphoid
7	Mandible
8	Sternum
9	Cubical bones of wrist
B Secondary osteochondritis (involvement of secondary centers of ossification or epiphyses)	
1	Spine (at puberty)*
2	Ribs (at puberty)*
3	Clavicle (after puberty)*
4	Patella (at puberty)*
5	Pelvic girdle (at puberty)*
6	Femur
7	Tibia
8	Fibula
9	Calcaneus
10	Metatarsals
11	Phalanges
12	Scapula
13	Humerus
14	Ulna
15	Radius
16	Metacarpals

\*These bones have primary and secondary centers of ossification developing at widely separated periods

secondary types have been described. The growth centers in the spine develop rather late and have two periods of active growth, the first involves the primary centers during the first decade, and the second the secondary centers during the second decade. A primary type may continue until the appearance of the secondary centers, or both types may appear simultaneously in the same patient.

Secondary osteochondritis of the head of the femur, also known as Legg's disease, Legg-Perthes' disease, Perthes' disease, Legg-Calvé-Perthes' disease, Calvé-Waldenström-Legg-Perthes' disease, osteochondritis coxae juvenilis, osteochondritis deformans, osteochondritis deformans juvenilis, coxa plana, pseudocoaxalgia, osteochondritis of the hip joint, or osteochondral trophopathy of the hip joint, is one of the most common of this group. It usually occurs in very active, well developed boys between the ages of 3 and 12 years, although girls are not exempt. The first symptom is a limp on the affected side, and this may be accompanied by local pain and

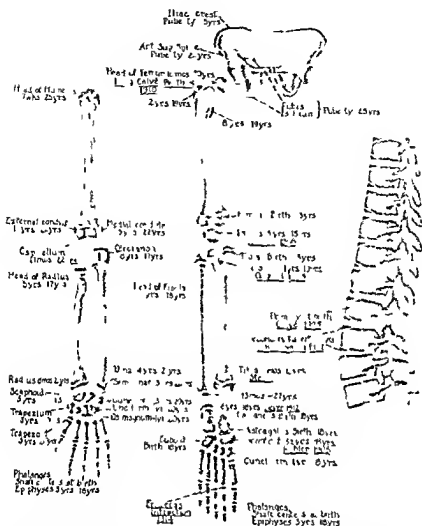


Fig. 1. Drawing of the ossification centers with the ages of appearance and final ossification with dates when the diseases were first described and authors who first reported them.

tenderness. A certain number of patients give a history of trauma. Osteochondritis (secondary) of the capital epiphysis is also common after reduction of congenital dislocation of the hip. In the early stages, examination and roentgenograms will probably be negative but in the course of a few weeks some wasting of the gluteal muscles on the affected side can be seen. Some general muscle spasm, as well as pain and tenderness, may be elicited. Abduction and internal rotation are slightly limited. The Trendelenburg sign is present.

Roentgenograms taken at this stage are characteristic. The ossification center of the epiphyseal head shows areas of rarefaction. Later it is flattened and fragmented into several pieces. The neck of the femur is thickened and shortened, the thickening is greatest near the epiphyseal line. In a few cases the acetabulum may be flattened. The resulting deformity of the head of the femur may be classed as either the cap or mushroom type. Legg calls attention to the different clinical courses which both types may run. In the mushroom type the chief complaint is



Fig 2 Case 1. There is considerable moth-eaten of the neck of the right femur with some flattening of the right and left capital epiphyses. Roentgenogram taken 5 months after injury.



Fig 3 Case 1. This roentgenogram taken 9 months later than the roentgenogram in Figure 2, shows generalized atrophy with increased broadening of the neck and irregularity of the capital epiphysis.

limping, without pain. There is also very little atrophy of the hip muscles. Motion about the hip is normal unless the epiphysis has migrated to the great trochanter, in such a case abduction and rotation are limited. Very little, if any, shortening is found in this type.

The cap type may run a much more severe clinical course. There is a great deal of fragmentation of the epiphyseal bone center. The neck is shorter and more rounded at the upper angle. "In a few cases the epiphysis seems to be obliterated" (Legg). The resulting loss in length and range of motion about the hip is more marked than in the mushroom type.

This disease must be differentiated from tuberculosis, coxa vara, congenital and acquired irregularities of the head of the femur as well as epiphyseal separation fractures. As the disease progresses the clinical course and X-ray findings are diagnostic. Undoubtedly, certain cases of adolescent coxa vara represent the end-result of an unrecognized osteochondritis of the femoral head.

**CASE 1.** An example is that of a white boy of 6 years, well until thrown off a merry-go-round 5 months before admission into the Lakeside Hospital. He did not complain of any pain about the hip immediately following the fall but began to limp a month later. After a period of 2 or 3 weeks pain developed in the right knee and soon afterward in the right hip. The disability increased until he be-

gan to walk on all fours. It is of interest to note that at the age of 6 months he won a prize at a state health contest.

The physical examination revealed a well developed and nourished boy. The right leg showed a shortening of 1 centimeter with atrophy of 2.75 centimeters of the right thigh 17.5 centimeters above the patella. There was no increased surface heat or periarticular thickening at the knee or hip. Motion of the hip was limited about 20 degrees in all other directions. The child walked with a definite protective limp on the right side.

Blood calcium was 13.1 milligrams, phosphorus 5.3 milligrams, blood and urine studies were negative. The roentgenogram (Fig 2), taken 5 months after the injury (January 17, 1929), showed definite



Fig 4. Bilateral osteochondritis of the greater trochanter. The patient showed no symptoms referable to the disease.





Fig. 5 Tibial tubercle showing variation in density as well as irregularity of outline. transverse line through the proximal portion suggested a fracture

motting in the neck of both femora considerably more on the right. The joint spaces were clear.

On January 24, 1929, shortly after admission to the hospital, the right hip was explored. The capsule as well as the articular surface of the head appeared normal while the neck appeared definitely hyperæmic. Several small specimens were removed just distal to the epiphyseal line. The bone appeared firmer than normal was hæmorrhagic and somewhat granular in appearance. All cultures including those for fungi were negative. The pathologist reported that no evidence of pathological changes was present in several sections of the cancellous bone.

After 6 weeks the patient was discharged to a convalescent hospital. At this time his right hip was held by a plaster spica in a position of extension and 30 degrees abduction. The splint was removed in 6 weeks. Nine months after exploration of the right hip he was free of symptoms and walked without a limp. At this time there was 30 degrees limitation to abduction and adduction of the right hip but no muscle spasm. Roentgenograms showed the epiphysis of the head of the right femur to be flattened and roughened. There was a slight degree of coxa vara. The head of the left femur showed suggestive early change of the same nature (Fig. 3). The legs were of equal length.

Phemister<sup>1</sup> has reported a similar case. He found a mild synovitis. A window removed from the anterior surface of the head extending into the ossification center showed the latter to be almost broken down in one portion and partly filled with granulation tissue. Cultures were negative. Within 5 months roentgenograms showed the defect to be entirely filled with new bone.

<sup>1</sup>Phemister, Arch. Surg. 1921.



Fig. 6 Early involvement of patella in Case 2. The center of ossification is irregular in outline and decreased in density. Note irregularity of contour of the condyles of the femur.

Practical recovery follows regardless of treatment. If the deformity is rather marked and is progressive, the affected limb should be held in moderate abduction by a short plaster spica. It is rarely necessary to maintain such physiological rest longer than 6 weeks. Occasionally, malacia, as evidenced by roentgenograms, makes further protection advisable, this can be cared for sufficiently by a Thomas ring caliper brace for a few weeks longer.

During recent years several authors have called attention to the potential danger of arthritis occurring in hips previously affected with osteochondritis. A few such patients have been seen by one of us. In the more severe cases the Whitman reconstruction operation seems to give the best results.

Similar changes may occur in the greater trochanter as illustrated in Figure 4.

Involvement of the proximal epiphysis of the tibia has been known as Osgood Schlatter's disease, Schlatter's disease, or tibial tubercle apophysitis. We designate this as a secondary type. Well developed, athletic boys are especially subject to this disturbance about the time of puberty, 12 to 16 years of



Fig. 7. Case 2. A year later than Figure 5. There is increased irregularity of the contour of the condyles, increased growth of the patella but greater degree of mottling.

age. The symptoms usually follow direct trauma or some form of violent exercise where the leg has been smartly extended at the knee. The patient complains of loss of speed in running and aching of the part affected after exercise or climbing stairs. The discomfort may be severe enough to cause limping. Examination may reveal tenderness and thickening of the soft parts about the tubercle. Usually the tubercle becomes definitely enlarged. Active extension of the knee causes pain in the region of the ligamentum patellae. Roentgenograms show irregularities in shape as well as fragmentation of the tibial epiphysis (Fig. 5).

This common condition is self limited regardless of treatment. Mild cases may be relieved by cross strapping of adhesive, resting over the tubercle. In more severe cases, flexion of the knee should be prohibited by a plaster-of-Paris splint over a period of a few weeks, during this period rest of the quadriceps should be practiced, and after removal of the splint, baking, massage, and active motion hasten recovery.

This disease of the patella can be due to usually as a primary type (Figs. 6, 7, 8). However, secondary ossification centers may be found near puberty. The primary type was first described by Fischer in a case involving tarsal scaphoid involvement as well. The sec-



Fig. 8. Case 1. Two years later than Figure 6. This shows the extent of the disease. All of the femora show some signs of atrophy.

ondary type has been known as the Studding Larsen or the Larsen-Johansson syndrome. The accessory center of ossification is usually at the outer margin of the patella. It may be mistaken for a vertical fracture where it has persisted as a separate center of ossification. Defects in ossification of the patella are not uncommon and when present are bilateral in about two thirds of the cases. In some cases, roentgenograms have revealed involvement of the patella alone when the symptoms were referable to the tibial tubercle. In others a typical roentgenological picture of osteochondritis of the tibial tubercle has been found with symptoms referable to the patella. This has been explained as due to a band traction tendinitis at the attachment of the patellar ligament to the tibial tubercle and injury of the patella itself.

The same change which occurs in the patella may also take place in the condyles of the femur, the osteochondral line presenting irregularity of outline of the osteoid portion.

Primary osteochondritis of the patella is, then, rare, common near the age of 6 years at which time the primary ossification center is rapidly growing. Secondary osteochondritis is frequent about puberty and may be associated with tibial tubercle involvement. In cases both primary centers are rapidly growing at this age.

Case 2. A white girl, 6 years old, was admitted to the Lakeside Hospital August 22, 1928, because of pain and swelling in the right knee. For a year the parents had noticed that she walked with a limp,



Fig. 9. A decrease in volume of tarsal scaphoid as well as irregularly noted previously

especially marked in the mornings. In a short time she complained of pain relieved by flexing the knee. She developed swelling about the right knee and night cries. At this time a plaster cylinder was applied to the leg for a period of 6 weeks. Roentgenograms showed early changes in patella and condyles of femur (Fig. 6). The patient seemed well for 3 or 4 months after removal of the plaster splint. At the end of that time she fell striking her right knee. Within 4 days the knee was more swollen and painful than it had been before.

The physical examination showed a well developed and nourished child. The positive physical findings were confined to the right knee. There was no shortening of the right leg but definite perarticular thickening about the knee with some tenderness over the internal joint space as well as the patella. The leg was held in 10 degrees flexion and passive motion beyond this point was painless but slightly guarded. There was increased surface heat.

Blood count showed 8,000 white cells, haemoglobin 90 per cent, differential count normal. Wassermann test was negative. Tuberculin test human and bovine dilution 1:5000 was positive. The urine was normal. Roentgenograms (Fig. 7) showed definite changes in the patella and articular surfaces of the condyles of the femur.

The knee was explored on September 15, 1928. The articular surface of the patella as well as the condyles of the femur had a normal appearance. The synovia was hyperæmic, purplish in color and hypertrophic. It was thought to be tuberculosis at the time of operation. Cultures and guinea pig inoculation of the 3 cubic centimeters of slightly turbid fluid found were negative. A pathological report of



Fig. 11. The broad flat head of the second metatarsal as well as the increased density of the shaft is a characteristic change



Fig. 10. Lateral view showing fragmentation of tarsal scaphoid

non specific synovitis was obtained from fringes of the synovia removed for study.

For 3 months after discharge from the hospital several plaster splints were applied after which time free use of the part was allowed. She was readmitted to the hospital January 7, 1929 because of persistence of pain and limited motion. The knee lacked 20 degrees of complete extension and 40 degrees of complete flexion. Attempts at further motion were painful and met with obstruction which seemed due to adhesions rather than muscle spasm. A wedging cast was applied and the patient discharged to a convalescent hospital.

On November 30, 1929, extension of the right knee was slightly limited but no swelling or pain was present. Roentgenograms (Fig. 8) taken November 23, 1929, showed definite improvement.

Treatment of either type of osteochondritis of the patella consists of physiological rest in a plaster cylinder for a few weeks depending



Fig. 12. Characteristic irregularity, enlargement and moth-eaten of the calcaneal epiphysis



Fig. 13 Case 3 Considerable mottling and irregularity of the head of the humerus as well as liping of the acromion

upon the severity of the disease. This is to be followed by massage and increase in active motion.

Primary osteochondritis of the scaphoid has been known as tarsal scaphoiditis, or Koehler's disease. It is one of the most common of the primary type. This condition occurs about twice as often in boys as in girls. The scaphoid is one of the last bones of the foot to ossify and develops from a primary center alone. The ossification center appears between the fourth and fifth years. Therefore, this disturbance rarely occurs before that age. The upper limit is about 12 years. Very few of these patients give a direct history of trauma.

The first symptom is a slight limp. Local signs of inflammation are present, such as pain, swelling, and redness. The pain is aggravated by exercise, but the patient may obtain relief by walking on the lateral border of the foot. Roentgenograms show the bone to be decreased one-half to one-fourth the normal size and irregular in shape (Figs. 9 and 10). The bone is increased in density and the normal architecture is lost. The spongy and cortical portions are indistinguishable. Gradually fresh bone develops around the condensed nucleus. In a year or two the bone may acquire natural shape and size.



Fig. 14 Case 3 Two years later. Healed stage of the disease in the upper epiphysis of the humerus

The treatment of the diseased scaphoid is that of physiological rest. When there is considerable pain upon weight-bearing, it is necessary to apply a plaster boot with moderate elevation of the long arch. The splint should be worn about 3 weeks and followed by the application of a soft inner sole, long arch support, and one-quarter inch elevation of the inner side of the heel.

Osteochondritis of the head of the second metatarsal is described as Freiberg's infraction, Koehler's metatarsophalangeal joint, juvenile deforming metatarsophalangeal osteochondritis, second Koehler's disease. This occurs most often in females between the ages of 10 and 15 years. Local pain upon walking referred to the part affected is the chief symptom. Localized tenderness, periarticular

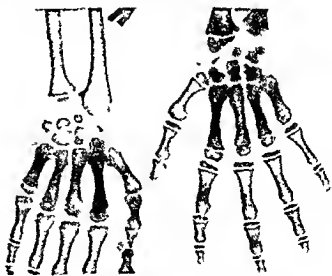


Fig. 15 Primary and secondary osteochondritis showing retardation of development of certain ossification centers, irregularity of the distal ulnar epiphysis, as well as epiphyses of four metatarsals



Fig. 16 Case 4. Lateral view of dorsal spine showing irregularity of contour of several dorsal vertebrae with mottling and representing a moderately advanced process (a diagnosis of tuberculosis of the spine had been originally made)

thickening and swelling are present. Plantar flexion of the foot may be limited. The onset often follows a strenuous tennis game in which the ball of the foot must repeatedly stand the impact of the body. Disturbed mechanics of the foot due to high heels has also been suggested as a cause. The first metatarsal exerts pressure because the epiphysis is located at the proximal end. Involvement of the second metatarsal is more common than of the remaining three because it is longer than the rest and bears the brunt of the body forces. Roentgenograms are diagnostic. The head of the second metatarsal is flattened and irregular (Fig. 11). Alterations in the structure of the head, condensation and rarefaction give the appearance of fracture at times. The cortical portion of the diaphysis usually shows thickening.

Relief is ordinarily afforded by a transverse leather bar three eighths inch thick upon the shoe just back of the position of the head of the metatarsals of the affected side with a moderately low heel. This serves to remove the weight from the part. In the severe type where loose bodies are present, their surgical removal with partial excision of the head of the metatarsal is required.

Osteochondritis of the os calcis is also known

as apophysitis. It is the only example of secondary osteochondritis in the cubical bones, except involvement of the accessory scaphoid in rare cases. This disturbance occurs most frequently in very active boys, from 8 to 14 years of age. These patients complain of pain about the heel upon walking. This is many times severe enough to cause a limp. Examination reveals pain and tenderness over the back of the heel. There may be thickening of the overlying soft tissues. Full dorsiflexion is limited and any strain on the tendo achillis causes pain. A history of direct trauma is not often obtained.

Roentgenograms may show a widening and cloudiness between the epiphysis and body of the os calcis. The epiphysis is often enlarged and irregular in outline, areas of condensation and rarefaction occur (Fig. 12).

This condition may be confused with a bursitis due to the irritation of a shoe. Tuberculosis generally affects the anterior portion of the os calcis. Other inflammatory diseases of the Achilles tendon can be ruled out by X ray and the duration of the symptoms.

As in all other types, this condition disappears when the epiphysis joins the diaphysis. However, some relief may be obtained by lifting the heel one quarter to one half inch, as well as giving a small inner side lift to the heel if any pronation of the foot is present. A soft felt or rubber pad may be placed under the heel. Local pressure produced by several vertical strips of adhesive passing around the heel may give relief.



Fig. 17 Case 4. Bilateral coxa vara which was a coincidental finding



Fig 18 Case 4 Appearance of the disease at about the healed stage The contour of several of the bodies remains irregular but the general contour of the spine is normal

The upper extremities are by no means exempt, for involvement of the head of the humerus has been reported in a case of birth injury (Lewin) Recently we have seen a similar case

CASE 3 A white boy, 8 years of age, was sent into the Lakeside Hospital November 22, 1929, because of disturbed function in the right arm Soon after his birth the mother had noted that the right arm was not used as the left At that time it was thought to be an Erb's palsy Roentgenograms of the right shoulder in 1927 (Fig 13) showed definite



Fig 19 Case 5 Same patient as in Figure 20 Mild degree of coxa vara and flattening of the left hip



Fig 20 Case 5 Dorsal kyphosis with considerable irregularity of outline of the vertebral bodies from sixth to eleventh inclusive

irregularity of the epiphyseal line with mottling of the epiphysis itself The patient was 6 years old at that time

The physical examination showed a well developed boy The right arm could be abducted only 35 degrees free of the scapula, with no external rotation, but normal internal rotation The head seemed to rest high in the glenoid cavity, and upon attempted external rotation there appeared to be a separation of the acromioclavicular joint Palpation showed definiteipping of the acromion over the head of the humerus Muscle power and sensation seemed normal throughout the arm In roentgenograms of the shoulder, taken November 18, 1929, the epiphysal plate was somewhat irregular but the epiphysis was more nearly normal (Fig 14)

On November 19, 1929, the distal portion of the acromion was excised and the pectoralis muscle divided This relieved the limitation of abduction and permitted complete external rotation of the arm The arm was placed in a plaster spica in 90 degrees' abduction and complete external rotation The early result showed excellent function

This condition may appear following injuries of this type, as in the cases which develop in congenital dislocation of the hip following reduction Panter has reported cases of the secondary type involving the elbow A direct history of trauma was com-



FIG. 21. Case 6. Dorsal kyphoscoliosis, the result of primary osteochondritis in the arrested stage.

mon in his cases. In Figure 15 both the primary and secondary types are present. The mottled and fragmented epiphysis of the ulna represents the secondary type. The primary type is represented by the mottled appearance of several of the bones of the wrist. Traumatic malacia of the carpal semilunar of Kienboeck, as well as the same type of process in the spine known as Kummel's disease, has been purposely omitted because of its occurrence in adult bone.

Vertebral disease has been one of the last to be recognized. At the present time we know that this condition is fairly common. Various authors have called it Scheuermann's

disease, juvenile kyphosis, adolescent kyphoscoliosis, kyphosis osteochondropathica, vertebral osteochondritis, vertebral epiphysitis, kyphosis dorsalis adolescentium, and kyphosis dorsalis juvenilis the latter two suggesting that portion of the spinal column most affected.

Attention to vertebral epiphyses was aroused by A. Koehler in 1915. According to Mau the vertebral bodies have two periods of active growth. The first period involves rapid growth of the primary centers of ossification. This activity is retarded from the age of 6 until the appearance of the secondary centers. The second period of growth extends over a period of 5 or 6 years. In girls the onset of this period is around 10 years and in boys several years later.

Calvé called attention to the fact that osteochondritis of the spine was sometimes found in the very young before the appearance of the epiphyses. This form has been called infantile osteochondritis. This primary osteochondritis may appear within the early years of life and produces a greater degree of deformity than the secondary type. In our series we have one of the primary type which shows a well defined scoliosis (Fig. 21).

The secondary type is the more common. In any case of well defined round shoulders occurring in early adolescence this condition must be considered. Several of our cases of the secondary type were sent by the school authorities to the orthopedic dispensary for examination.

The symptoms and roentgenograms vary according to the degree of advancement of the primary or secondary types. Deformity is often the only complaint of either type. In the primary type the spine may be tender and spastic simulating Pott's disease. The very young patients may have an awkward gait. Many cases of the primary type have been found by reviewing the roentgenograms of a case with supposedly Pott's disease which made a remarkably early recovery. By the time the symptoms or deformity become severe enough to cause the patient to seek medical aid the roentgenograms are characteristic. There is early mottling and irregularity of contour of the vertebral bodies most affected, which are usually in the low dorsal



Fig. 22 Case 6 The lateral view is not clear but irregularity can be noted in the lower dorsal bodies

region. The bodies become wedge shaped and often are almost completely lost. This results in angulation of the spine at this point depending upon the degree of absorption. In the final stages sclerosis takes place and the mottled appearance decreases. The deformities in untreated patients are usually permanent. These early spinal deformities may be mistaken for Pott's disease or rickets. Some of these patients complain of local discomfort at the site of angulation. Buchman<sup>1</sup>, however, concludes that vertebral epiphysitis is not found in deformities of the spine of known origin, such as poliomyelitis, Pott's disease, rickets, torticollis, congenital deviation and inequality of the lower limbs.

Many cases of osteochondritis of the vertebrae of the secondary type (Fig. 26) have been so diagnosed because of roentgenograms taken to discover the cause of round shoulders, or as in the primary by the review of roentgenograms of a self-limiting, typical case of Pott's disease. In several of our cases the patients gave a past history of backache, malaise, and pain in the hips, but their complaint upon entering the dispensary was largely referable to the deformity of the spine.

<sup>1</sup>Buchman Arch Surg 1926



Fig. 23 Case 7 The lateral view shows no definite changes in the bodies at this time

The secondary centers are represented by small triangular bodies at the anterior superior and the anterior inferior margins of the vertebral bodies (Fig. 2). Normally, the outline of the vertebral bodies should be regular and distinct. The intervertebral spaces should be of uniform density throughout. If the intervertebral spaces are cloudy throughout, no significance is attached unless the vertebral bodies are mottled or irregular in contour. In the very early stages, the epiphyses are often enlarged and irregular in outline. The intervertebral spaces are cloudy and seem to blend with the general mottling of the vertebral bodies. The margins of the vertebral bodies are irregular and indistinct. In some cases they appear almost completely destroyed, as in a well advanced case of Pott's disease (Fig. 20). Even at this stage the patient may be without symptoms, although the deformity exists. Gradually from the moth-eaten mass the sclerosed vertebral bodies become better defined. In this stage the bodies show more





Fig 24 Photograph illustrating spinal posture of Case 5

clearly their irregular and fragmented borders as well as a wedge shaped deformity which remains permanent (Fig 18)

We have included short case reviews of osteochondritis of the spine occurring definitely in three members of the same family, the fourth member, a girl about 12 years of age, has well defined round shoulders but no suggestive symptoms, and the roentgenograms are negative as shown in Figure 23. We believe that she will gradually show changes in her spine as the other members of her family have done. In the two well defined secondary types (Figs 17 and 19) the hips show coxa vara with flattened capital epiphyses.

No doubt if complete roentgenograms of the skeletal system were taken on every case of supposedly localized osteochondritis, many additional involved centers might be found.

The first of the following histories represents progress of the disease from an active to an almost healed stage.

**CASE 4.** A white boy, aged 15 years entered the Lakeside Hospital dispensary on January 29, 1924 complaining of "spine trouble" and wearing a plaster jacket. The present illness started 2 years previously with an intermittent pain in the lower portion of the spine and at the onset he was treated in another hospital where a plaster jacket was applied. A tentative diagnosis of Pott's disease was made. On May 17, 1924 the jacket was removed and a brace applied. In July he returned complaining of stiffness

in the legs present for the preceding 5 weeks. The Wassermann was negative. Roentgenograms of the dorsal spine showed irregularity in contour of the seventh and eighth dorsal vertebrae quite suggestive of a destructive process involving these bodies (Fig 16).

Roentgenograms of the hips taken December 6, 1924 showed a coxa vara of both hips (Fig 17). The head of the left femur was rather indefinite in outline. The patient was not seen again until July 11, 1929. The physical examination at this time revealed an unusually well developed boy of short stature (Fig 25). The contour (Fig 18) and mobility of the spine were relatively normal.

This case represents one of the common examples in which osteochondritis of the secondary type was mistaken for tuberculosis of the spine.

**CASE 5.** A white girl 12 years old of the same family was first seen January 24, 1925 in the Pediatric Dispensary complaining of "pain in the left side of 2 days' duration." Examination revealed a dorsal kyphosis with tenderness over the lower cervical vertebrae. Roentgenograms of the cervical spine showed no definite evidence of pathology. Tuberculin test (1:1000) was negative.

On February 23, 1926 she was sent in by school authorities because of round shoulders and slow growth. The physical examination at this time was negative except for the moderate degree of round shoulders. The trunk of the body seemed short in relation to the extremities. She was not seen again until October 13, 1928 and at this time the round shoulders and lordosis were exaggerated. She complained of intermittent pain in the left hip worse when standing. The mother said that the patient limped occasionally. There was no evidence of focal infection. A roentgenogram of the pelvis showed a moderate coxa vara bilateral (Fig 19).

She returned June 8, 1929 (Fig 24) with the same type of pain in the hips as well as in the knees, with no tenderness or muscle spasm about the spine. The kyphosis was moderate. Roentgenograms (Fig 20) of the dorsolumbar spine showed marked destruction of the anterior portion of the eighth dorsal vertebral body. There were many defects in the lower portions of the bodies of the sixth, ninth, and tenth dorsal vertebral bodies. The patient continued to complain of so much pain in the hip that she was sent into the hospital on the orthopedic service for further study. All laboratory studies were negative but because of a questionable heart lesion and history of rheumatic fever the patient was transferred to the medical service. A definite diagnosis of rheumatic heart disease was made. During her stay in the hospital she was kept in mild hyperextension by a pillow roll under the midportion of the spine.

This patient demonstrates the onset and active stage of this disease.

**CASE 6** A 10 year old boy, of the same family, was sent into the Lakeside Hospital dispensary, February 23, 1926, from school because of his posture and apparent failure to grow normally. The physical examination revealed a fairly well nourished boy but short in stature (Fig 25). There was a marked lumbar lordosis and sharply rounded dorsal spine with a right dorsal left lumbar scoliosis (Figs 21 and 22).

When seen on May 25, 1929, his condition was apparently unchanged. He came in by request on July 11, 1929, at this time the kyphoscoliosis had increased slightly.

**CASE 7** The youngest member of this family, a girl aged 10 years, was also sent by the school authorities for examination because of poor posture. She had been round shouldered for some time, but free of complaints. The physical examination revealed a well nourished and developed girl apparently in excellent health. The positive findings were limited to moderate degree of round shoulders. There was no tenderness or muscle spasm about the spine. Roentgenograms (Fig 23) were negative. We believe, however, that this patient will eventually develop changes in the spine similar to those of the secondary type already reviewed.

The treatment should be directed toward (1) the prevention of deformity, (2) the correction of deformity if it has already occurred, (3) the relief of pain, and (4) the improvement of general bodily posture.

It can be seen from the cases presented here that pain usually does not play a prominent part toward bringing the patient to the physician. Round shoulders and increased dorsal curve are the most frequent complaints.

During the early period of the disease when pain is complained of, absolute physiological rest is indicated. The child should be placed upon a Bradford frame with angulation of 20 to 35 degrees. The apex of the curve of the spine should rest at the maximum angulation of the frame, thus maintaining the spine in moderate hyperextension. When all muscle spasm has subsided, the patient may be allowed up, either with a plaster jacket or a spring back brace. Sleeping upon the hyperextended frame should be continued until all deformity has been corrected and the brace removed when roentgenograms show a uniform density and outline of the individual vertebrae. Those patients who present no complaint other than deformity require a period of recumbency upon a hyperextended Bradford frame for several hours daily. This

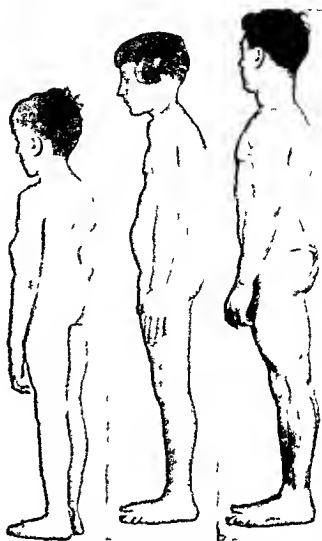


Fig 25 Photographs illustrating the spinal postures of Cases 4, 6, and 7.

should be continued until the maximum correction has been obtained.

Corrective exercises should be directed toward hyperextension of the spine, in such a manner as to restore the normal physiological curves. They should always be started immediately following subsidence of pain in the acute cases, such patients as present only deformity should begin the exercises at once.

When there is a lateral curve combined with an exaggerated anterior posterior curve, the exercises should be of a more specialized character. The general posture of the individual should be considered at all times.

#### ETIOLOGY

There have been as many etiological factors suggested for this disease as there have been



Fig. 6 Moderately advanced osteochondritis of the secondary type occurring in a girl 14 years of age

names. To our knowledge the etiology has never been clinically or experimentally proved. It cannot be denied, however, that trauma either in a direct or indirect form plays a major part in many instances regardless of location. A definite history of trauma was obtained in Case 1. It cannot be denied as a factor in those cases which develop following birth injuries and congenital dislocation of the hip. A traumatic factor is often present in cases involving the elbow, tibial tubercle, and second metatarsal.

Indirect violence due to increased stress and strain resulting from muscle or tendon traction is another important factor. The disease is most common at the points of increased stress, for example the head of the femur, heel, and scaphoid. The scaphoid, the last of the ankle bones to ossify, is subject to increased stress. The tibial tubercle and calcaneus because of attachment of a large ligament also fall into this group. The vertebrae are involved in the low dorsal region where the vertebral bodies are subjected to

increased indirect trauma. This is true in both the primary and secondary involvement of the spine.

In many cases a history of direct trauma is not obtainable, therefore, another factor must be considered to explain the selective factor in certain cases. Why should the spine be affected in four members of the same family? Hanson considers heredity as a possible etiological factor in vertebral disease. He bases his conclusions on 6 cases showing involvement in a child, parent, and grand parents. Perhaps a tendency toward malacia of ossification centers during periods of active growth may be of hereditary origin.

Leriche and Polcard in their book on *The Physiology of Bone* offer an explanation on the basis of vasomotor changes. The fact that increased circulation results in bone rarefaction is well established.

There frequently exists osteoporosis, more or less localized or diffuse, which is developed after peripheral nerve trauma. These instances are observed especially in the small bones of the hand and of the foot after an accident which has apparently not been serious. In a few weeks an 'atrophy' of the bone, a decalcification is visible on radiography. It is accompanied by pain and functional impotence which at times are wrongly called traumatic arthritis.

The affected bones are rarefied. We know that there is no rarefaction without hyperemia and that hyperemia can be accompanied by it. Now, on the other hand, all peripheral nerve traumatism is accompanied by a more or less lasting disturbance in equilibrium which begins with vasoconstriction and quickly turns into a vasodilation which the oscilometer clearly shows.

This is what we have called reflexes of the traumatized axone. Alberti has shown that experimentation brings about this state in conditions which permit of no other interpretation.

Here it may be properly asked whether a parallel mechanism is not the origin of certain singular syndromes which have been elevated to the dignity of specific bone diseases, such as the *tarsal scaphoiditis* of Koehler, the *traumatic malacia of the semilunar* of Kienboeck, the *osteochondritis deformans of the hip* Calvé, Waldenström, Legg, Leri's disease, and the vertebral deformities of Kummel, Verneuil disease.

It is very probable that still other isolated localizations of this bone rarefaction of traumatic vasomotor origin will be found and that other specific diseases will yet be diseases of  $\lambda$ — or of  $\lambda$ —. One can say that from now on all will have the same character: an insignificant trauma or one

distant in origin, in evolution which is slow, progressive, irritable, accompanied by slight pruritus and resulting in final spontaneous curability, with at times definite bone deformity and absence of all signs of inflammation. Up to the present, pathology has not taken account of the reflexes of the traumatized bone. Now that the intimate relation which unites vasodilation and bone resorption is known, it is permissible to believe that the syndrome which they bring about should be frequent.

It would be difficult, however, to explain on this basis the bone sclerosis in the neck of the femur and diaphysis of the second metatarsal which accompanied the rarefaction of the epiphyses. Perhaps a combination of these factors plus some underlying cause with which we are not as yet acquainted may be responsible for the disease.

#### SUMMARY

The literature on osteochondritis includes almost seven hundred articles. Up to the present time no attempt has been made to simplify the multiplicity of terms used to describe the same type of pathology which occurs in various ossification centers of the body. We have attempted to bring together a review of the literature upon this disease in an effort to simplify and standardize the terminology. This study was prompted by four cases of vertebral involvement occurring in the same family.

The anatomy and age incidence of the centers of ossification have been discussed in order to explain our classification as well as to define the age limits. This combined with a historical review has been illustrated in Figure 1.

Osteochondritis involves either the primary or secondary center of ossification during their periods of active growth. The disease is self limited by complete ossification.

To include all types of osteochondritis we would classify them either into the primary or secondary type depending upon whether the primary center of ossification or secondary center is first involved. This classification immediately places involvement of all the cubical bones of the wrist and the feet, except the calcaneus, into the primary group. These

bones do not have secondary centers of ossification, except the calcaneus and occasionally the accessory scaphoid. In the spine both the primary and secondary types have been described. The epiphyses in the spine develop rather late and have two periods of active growth, the first involves the primary center during the first decade and the second the secondary center during the second decade. A primary type may continue until the appearance of the secondary centers, or both types appear simultaneously in the same patient.

The more common locations are discussed, including terminology, symptoms, roentgenological findings, prognosis, and treatment. Case reviews of hip, patella, humerus, and 4 cases of spine involvement in members of the same family are given. Both primary and secondary types of osteochondritis are represented in the cases of spine involvement, the secondary cases representing the disease in the initial, active, and arrested stage.

The etiology of the disease is unknown. However, direct trauma, or indirect trauma as a result of increased stress and strain from the body forces, appears to play an important role. Heredity may be considered as a possible etiological factor as considered by Hanson and represented by our series of four members in one family having involvement of the spine. Leriche and Polcard offer an explanation from vasomotor changes based on the reflexes of the traumatized bone. Perhaps a combination of the factors added to some unknown cause may be found to be responsible for this disease.

The treatment varies according to the location of the disease. In general, a period of physiological rest of 4 to 6 weeks is essential. When plaster supports are dispensed with some mechanical device may be used to prevent recurrence of the deformity until the period of active growth of the center involved is over. It is thought chronic arthritis may develop in the involved areas in later years.

NOTE.—A complete bibliography of some seven hundred references will be printed in the reprints of this article.

## A CYSTIC DERMOID TUMOR OF THE SPINAL CORD

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**T**ERATOMA cysts of the dermoid type arising in relation to the spinal cord are relatively uncommon. A search of the literature has revealed the records of 13 cases extending over a period from 1883 to 1928. The comparative rarity of the condition, therefore, as indicated by its bibliography, the interest which attaches to the unusual sequence of the clinical history, and the distinctive feature of its morbid anatomy are the reasons which would seem to justify the publication of the present record.

G. D. aged 22 years, miner, single, was admitted to the hospital December 4, 1928.

*History.* In December 1927 the patient suffered from a severe attack of influenza. There was some post influenza disability, but by March 1928 a condition of reasonably good health had been regained. Early in July 1928 a sensation of discomfort was complained of over an area in the small of the back, which according to the patient's description could be covered with the palm of the hand. Though most marked in the midline, the discomfort occasionally passed in a girdle like manner around the waist and extended into both groins. When asked to describe the sensation of discomfort the patient replied that it was a curious numblike feeling with occasional shooting pains. It was apparent that the symptom was aggravated by weight bearing and movement, for there was exacerbation at the end of a day's work or after a long walk. Correspondingly, rest, particularly in a prone position gave some measure of relief.

At the end of August the discomfort altered in character, becoming definitely painful and persistent. Its area of distribution extended so that the pain radiated into the buttocks and along the posterior aspects of both legs as far as the ankles. There was also a distribution of pain in a girdle like arrangement round the abdomen and extending from xiphisternum to umbilicus.

The condition was at this time regarded as a lumbago, and investigation by a careful medical observer revealed two points either or both of which was suspected of being related to the vertebral and abdominal pain. These were a moderate amount of bilateral pes cavus and an unusually pendulous scrotum with bilateral varicocele. It was believed that the former error was responsible for a derangement in the mechanics of the dorsolumbar region and that the drag of the pendulous scrotum might explain in some measure the abdominal and groin pains.

In the latter half of September a new feature made its appearance, the patient noticed that just as sleep was approaching there would occasionally be a series of generalized and clonic contractions of the muscles of both lower limbs. It was a disconcerting development which delayed his sleep and which might be repeated several times in the night.

During the last week of October the first evidence of interference with the gait appeared. The patient noticed that after walking for a few minutes he experienced a sensation as though he had lost control over one or other of his lower limbs. The derangement was first noticed in the left leg, but later it appeared on the right side and occasionally both legs showed the error simultaneously, so that if he could not clutch at some adjacent support, he fell to the ground. About this time the patient first became conscious of tingling sensations and feelings of pins and needles in the limbs, more especially on the anterior aspects of both thighs.

During November the weakness of the lower limbs, the paresthesia and the occasional muscular spasm continued, the pain, both local and radiating became more acute and the low thoracic region of the spinal column acquired a rigidity in an attitude of mild kyphosis which interfered still further with the gait. The pain, the interference with sleep and the increasing sense of mental depression affected the general well being, but the appetite remained good and there was no loss of weight. As early as the middle of October the patient had noticed what at first appeared to be an increasing frequency of micturition and by mid November it was evident that there was some interference with bladder control. The patient had difficulty in retaining his urine and it occasionally passed without his knowledge. Constipation had been a lifelong feature, but it was noticed that with the derangement in the urinary function there was an increasing tendency to urgent defecation.

The patient's father is 55 years old. Eight years ago he had a cerebral hemorrhage and is now a hemiplegic. The mother, a woman of 40 years, suffers from diabetes. The family numbered 11, and one child died in infancy of meningitis.

*General examination.* The patient was a young man in good general condition. His intelligence appeared to be below the average, questions were answered in a slow, hesitating manner, and it was difficult to elicit reliable information in such details of examination as the investigation of tactile sensibility. The gait showed an evident rigidity of the lower spine, while the movements of the lower limbs gave an impression of spasticity, particularly on the left side. While in bed the patient preferred to lie supine with the hip and knee joints flexed.

**Nervous system** Cranial nerve function was normal. There was wasting of the muscles of both lower limbs, and this feature was particularly noticeable in the extensor muscles of the left thigh. All voluntary movements could be carried out, but they were slow and unduly deliberate, and they were arrested by a moderate amount of resistance. The co-ordinative functions of the muscles of both lower limbs were interfered with. There was flaccidity and evident weakness in the subumbilical portion of the rectus abdominis and in the lower portion of the oblique and transversalis muscles. No response could be obtained to stimulation of the cremaster muscle and the unduly pendulous condition of the scrotum has already been referred to. The musculature of the back, the upper limbs, and the head and neck showed no error.

Perhaps the most remarkable feature in this stage of the investigation was the variability in the results of the sensory function as shown from one day to another. There was a constant loss of tactile sensibility on the outer aspects of both thighs and over the abdominal area from the subcostal line downward. In the other areas the recognition of tactile sensibility was normal (Fig. 1). The distinction of superficial pain was abolished over the outer aspect of the left thigh. The induction of pressure pain resulted in an exaggerated appreciation in all parts of the lower limbs. In three areas of the lower limbs there was inability to distinguish between sensations of heat and cold. These areas were the outer aspect of the left thigh, the anterior surface of the right leg from the knee to the ankle, and an area on the anterior surface of the scrotum on the left side (Fig. 2).

Investigation of the compass test (Weber's) showed that this appreciation was lost over the skin surfaces of both lower limbs below the knee (Fig. 3). There was evidence that the sense of position in both lower limbs was deficient, but it was difficult to secure the co-operation of the patient in investigating the point.

A girdle area of numbness and tingling extended from the subcostal line upward for a distance of about 2 inches. There were areas of tingling on the inner aspect of the left thigh and over the dorsal surfaces of both feet. A constant area of paræsthesia existed above the left groin.

An extensor response (plantar reflex) was elicited in both feet. The cremasteric reflexes were absent on both sides, the abdominal reflexes were also absent from a level immediately above the umbilicus downward. Oppenheim's sign was present in both lower limbs. There was exaggeration of the knee and ankle jerks on both sides, those of the left side being more active as contrasted with the right. An adduction response was elicited on the left side. Ankle clonus could be elicited on both sides, but more readily on the left. There was some degree of retention of urine. It was passed at frequent intervals, but the patient might be unconscious of its passage. The average amount passed at one time

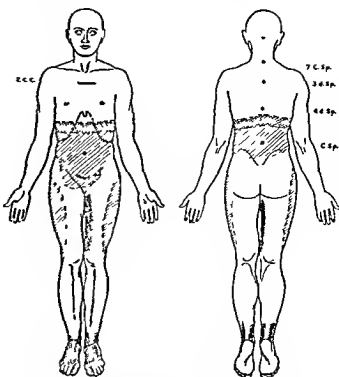


Fig. 1. The crossed diagonal lines indicate the areas of hyperæsthesia and the diagonal lines indicate the areas of anaesthesia.

was 4 ounces. Under ordinary conditions there was troublesome constipation, but when the stools were liquid, as was the case after a purgative, there was a precipitate action of the bowel. Rectal examination revealed a loss of the sphincteric tone.

The circulatory, respiratory, urinary, and alimentary systems revealed no abnormal features.

Wassermann reaction of cerebrospinal fluid was negative. Lumbar puncture at the level of the third lumbar interspace revealed a limpid fluid, slightly straw-colored, there was no apparent increase of pressure. Examination of cerebrospinal fluid showed a cell count of 1 per cubic centimeter (small mononuclear), globular content slight increase, colloidal gold reaction 0012200000.

**X-ray examination.** An ordinary examination of the vertebral column revealed a moderate degree of lordosis in the thoracolumbar spine with a wedge appearance of the fifth lumbar vertebra.

On December 7, 10 cubic centimeters of warm lipiodol was injected into the subdural space at the level of the third lumbar interspace. The patient was then placed in an inverted position, and after 15 minutes the vertebral column was X-rayed in anteroposterior and lateral position. It was found that the upward passage of the lipiodol had been arrested at the level of the body of the eighth thoracic vertebra (Fig. 4).

**Cistern puncture and Queckenstedt's test.** Cistern puncture revealed cerebrospinal fluid under normal pressure. Specific gravity 1.006, cell count 1 per cubic centimeter (type not stated), globulin not increased. By means of Ayer's method an attempt

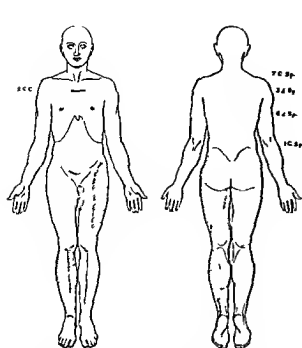


Fig 2 Shaded areas indicate loss of thermal sensibility

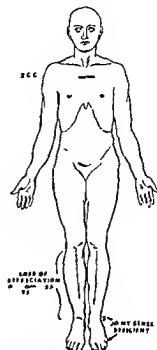


Fig 3 J stimulation of joint sense and compass test

was made to demonstrate whether or not a spinal block existed but the result was unsatisfactory.

**Provisional diagnosis** All the data of the past history and the objective examination indicated a pressure influence upon the spinal cord only by this explanation could one account for the sequence of events in the clinical history the spasticity and increasing weakness of the musculature of the lower limbs the disturbance of sensation in the same areas and the serious derangement of the organic reflexes. The site of the disturbance appeared to be at the level of the seventh or eighth thoracic segment this being indicated by the distribution of the sensory disturbance and confirmed by the evidence of the lipiodol injection.

The transverse localization of the lesion was next considered. The X ray examination of the vertebral column excluded an osseous source a pressure influence originating in the extradural space was apparently negatived by the distribution of the motor and sensory disturbances a meningeal source was considered in such various forms as hypertrophic pachymeningitis the circumscribed serocystic leptomeningitis (Krause and Horsley) chronic syphilitic meningitis and the group of meningeal neoplasms. It was thought that these possibilities might be excluded in the absence of previous infective influences and the closely coincident onset of motor and sensory disturbances. An extramedullary meningeal tumor was debated, and in view of the partial one sidedness of the physical signs (left side) and the evidence of root pressure, this was the provisional diagnosis, though in view of later find-

ings it was evident that it was difficult to associate a meningeal neoplasm with the alteration in superficial and deep sensations and the apparent coincidence of motor and sensory disturbances. However the provisional diagnosis was made of an extramedullary meningeal tumor, either posterior or posterolateral in position.

**Operation** December 11 1928 Prone position and intratracheal anesthesia. The sixth thoracic space was indicated by a skin scratch and recognizing that level as the center of the area to be brought under review the spinous process was exposed by a longitudinal incision slightly convex to the left. The mass of the erector spinae muscle (spinalis dorsi) was separated from the lateral surfaces of the spinous processes and from the posterior surfaces of the laminae. Hemorrhage was controlled by gauze packs and when bleeding was arrested, the muscular masses were held apart by self retaining retractors. After division of the supraspinous and interspinous ligaments the spinous processes of the fifth sixth seventh and eighth thoracic vertebrae were removed. The ligamentum flavum between the laminae of the seventh and eighth vertebrae was divided and by means of the access thus gained the spinolaminar segments of the fifth, sixth and seventh vertebrae were removed. This gave access to the extradural fat with its venous plexus, careful gauze dissection removed the layer and laid bare the glistening dural surface. Particular care was taken at this stage to arrest all hemorrhage and the area was bathed in a warm solution of 2 per cent novocain. Loop sutures were inserted into the dura

on either side, and the membrane was opened in the midline. Mesial division of the arachnoid membrane followed, and the posterior aspect of the spinal cord covered with pia mater was exposed. No tumor was apparent in the area under review, and further orientation was therefore necessary. This was achieved by the insertion of a lumbar puncture needle into the subdural space at the level of the first lumbar interspace and the injection of 5 cubic centimeters of sterilized methylene blue solution. As the injection did not appear in the operation field, it was assumed that the compressive influence existed below the operation level, and the spinolaminar segment of the eighth thoracic vertebra was therefore removed, the mesial dural and arachnoid incisions were prolonged downward and a further segment of the spinal cord exposed. A tumor was now apparent. Its surface was silver-gray and glistening in appearance, it resembled a date stone in outline, its length measured 4.5 centimeters, its maximum diameter was 0.7 centimeter. It appeared to be invested by the pia mater, and its central long axis corresponded accurately to the posterior median fissure of the cord. The appearances were those of a dermoid or epidermoid cyst and, after careful division of the investing pial layer, the cyst was easily enucleated. The cavity which remained was actually an exaggerated posterior median fissure, tapering into the normal outline at the higher and the lower levels, the appearance at the center of the long axis of the cavity suggesting an incomplete duplication of the cord. The center of the cyst corresponded to the upper level of the ninth thoracic segment (Fig. 5).

The cyst proved to be of the epidermoid type, that is to say, its walls were formed of a basement membrane lined with several layers of epithelium, no glands or hair follicles being represented. The contents were pultaceous and composed of fat, cholesterol, and round glistening friable bodies formed by the concentric deposition of epidermoid flakes and degenerate cells, characteristics which gave the contents an appearance resembling that of the cholesteatoma.

#### THE CYST ORIGIN

If, following the description of Salotti (2), we subdivide teratomatous cysts into dermoid and epidermoid types according to the structural characters of the cyst wall, the condition under discussion was an example of the epidermoid variety.

When we recall the developmental processes by which the spinal cord arises, it is evident that an epidermoid cyst of the spinal cord will rank in Bland Sutton's classification as a sequestration type. The infolding of the ectodermic neural groove to form the neural tube is the natural procedure, and it is evident



Fig. 4. Roentgenogram of spinal column showing arrest of lipiodol at the level of the eighth thoracic segment.

that any further inclusion of ectodermic tissue may be the process by which a sequestration cyst may arise.

Torok (3) attaches importance to the date at which the pathological ectodermal inclusion occurs. He believes that a very early inclusion means the isolation of ectoderm, the cells of which are completely potential and are therefore capable of the formation of hair and glandular appendages. Inclusion of a later date involving cells the function of which is already determined—unipotent, simple cutaneous cells—means that the walls of the epidermoid cyst are composed of one or more layers of flattened epithelium. Arguing from this basis, Bostroem (1) believes that the epidermoid cyst has its origin in an inclusion error which dates from some time between the fifth and sixth week of intra-uterine life. This must of necessity, however, remain a



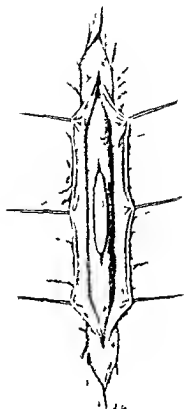


Fig 5 The cystic dermoid tumor of the spinal cord as it appeared at operation

polemic question, and one with no real practical significance. It is evident that the cyst under discussion has arisen by reason of an inclusion of ectodermal tissue superadded to that which normally occurs in the course of the formation of the spinal cord, and probably the exact origin may be pictured somewhat as follows. On division of the ectoderm into horny layers and medullary plate, cells of the horny layer have remained in the substance of the medullary plate, and have there developed into a sequestration cyst.

#### THE PATHOLOGY OF THE CYST

The cyst occupied a position which might be described as subpial and extramedullary. It lay in immediate contact with the spinal cord, its presence produced a considerable cavity formation in the outline of the cord, yet it lay on the surface and no division of nerve tissue was necessary either to expose or to remove it.

A study of the literature recalls how varied are the situations and depths of cysts of this type—extradural, intradural, pial, intramedullary, and intraependymal—and these very variations in depth would seem to support the hypothesis that there is a distinction in the time incidence at which these cysts originate. Verebelley's (4) case is sometimes quoted as a demonstration of this point. A boy of 15 years showed two cysts, extradural in position, one typically dermoid in structure, the other lined with embryonal neuroepithelium, a canal unlined by epithelium connecting the two cavities.

In the present instance the level of the cyst was at the upper limit of the ninth thoracic segment, and this is in keeping with the records of previously recorded cases. The thoracolumbar area is the position of election. In 13 cases recorded in the literature the cyst distribution was as follows: 6 lumbar, 4 thoracic, 2 cauda equinal, 1 diffuse and multiple.

It is significant that it is in this area that the majority of spina bifida errors appear, and it is interesting to surmise what the influences are which predispose this segment of the body to such congenital errors.

#### CYST WALL AND CONTENTS

The silver gray appearance of the cyst wall was an impressive feature; it was produced by an unpigmented epithelium, thin enough to permit appreciation of the color of the pulsataceous contents. Microscopical examination of the wall showed that it was composed of elongated epithelial cells, three to five layers being the average thickness. Those cells which lay next the cavity were crudely ependymal in outline, they were obviously proliferating, and their desquamation produced the contents with which the cyst lumen was filled. The cyst wall was relatively avascular, a few vessels lay in the subepithelial space. The nature of the contents has already been described (Fig 7).

#### THE CLINICAL FEATURES

Viewed from a pathological basis, it might be anticipated that pressure effects on the columns of Goll and Burdach gave rise to



Fig 6 Section of cyst wall showing laminated epithelial lining ( $\times 240$ )



Fig 7 Photomicrograph of cyst wall showing a tendency to ependymal formation in certain cells ( $\times 240$ )

the original and outstanding clinical signs. It will be recalled that these tracts are ascending in character, and are concerned with the transmission of the following types of sensation: (1) the tactile sensation which recognizes two separate points of contact, (2) tension impulses arising from muscles and tendons, (3) position sense as transmitted from articulations, (4) impulses indicating the sensation of vibration.

It is of interest to recall for a moment in tabular form the epochs of the case history, and they may be summarized as follows:

December, 1927	Influenzal illness
July, 1928	Pain in lower thoracic spine
	Early girdle sensation
August, 1928	Pain in posterior aspects of both lower limbs
September, 1928	Clonic spasm in both lower limbs chiefly evident at night
October, 1928	Ataxic gait, loss of sense of position in lower limbs, particularly on left side; paresis on lateral aspects of both thighs
November, 1928	Disturbance of organic reflexes. Rigidity in spinal column

It is apparent that until July, 1928, that is to say during 21 years of life, the cystic tumor

had been existent and tolerated. Its influence as a deforming factor on the posterior column of the spinal cord was probably a matter of accommodation in respect of the nerve tissue, and, so long as this could be arranged, no symptoms arose. It is interesting therefore to surmise what was the factor which instituted the increased pressure and so led to the progressive development of symptoms. It was suggested that the influenzal infection might be responsible in so far as it induced a congestive change in the cyst wall and thus increased its relative bulk, but the comparative avascularity of the cyst, and the length of time which elapsed between the infection and the first signs of nerve pressure, would seem to exclude this explanation. It is more likely that the symptoms arose when disparity appeared between the ratio of growth of the cyst and the body tissues. Hitherto both had been growing at a relatively equal proportional rate, after the age of 21 years the growth of the spinal column ceased, the vertebral canal reached its maximum caliber, but the cyst continued to enlarge, and it was but a matter of a few months before the disproportion factor asserted itself and pressure on the posterior columns of the cord began to be exerted.

The stage of pain in the back was evidently synchronous with the first pressure effects. A root cycle then developed, it was bilateral in character and due to irritation of the posterior nerve roots as they lay between the enlarging tumor and the relatively fixed points of the ligamenta denticulata. It was significant that, in contrast to tumors arising from the meninges of the cord, pain was relieved when the patient was recumbent and was exaggerated by the erect attitude, while it was accentuated by weight bearing and by movement.

The further clinical history was that of a gradually increasing spinal pressure from a focus occupying a posteromedian position. Severe convulsive contractions, mainly evident at night probably owed their origin to stimuli of the anterior root fibers, and the nocturnal incidence of the feature suggests that a congestive stimulus, activated in some measure by the dorsal position, may have been at work.

Three months after the onset of symptoms the most evident features were those originating from pressure on the posterior tracts of the cord—ineordination in the purposive movements of both lower limbs, an ataxic gait, a loss of appreciation of the sense of position and of the compass test. The absence of the Brown Sequard syndrome should have proved an important indication in the orientation of the tumor. The syndrome appears when the conductivity of one half of the spinal cord is largely interrupted, in the case under review it is evident that the position of the cyst was so exactly central that, as expansion occurred, the pressure was distributed in a relatively equal fashion on both halves of the cord.

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## VARICOSE VEINS AND THEIR TREATMENT BY THE INJECTION METHOD

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THE time has come when the thoughtful clinician need wait no longer for further evidence to allow him to decide on fact as to the best method of treating varicose veins of the lower extremities. In the last 2 years the literature, notably from France, England, and this country, has grown voluminously and detailed in its description of the injection method of treatment and in the statistical comparison of its results with the operative method. In every instance experience has yielded uniform results regarding its safety, its advantages over the operative treatment, and its contra-indications. As well, experience has brought forth warnings against the misuse to which this treatment is naturally susceptible because it is a relatively easy treatment which can be administered in one's office. Aside from technique, unless the physician understands the circulation of the limb and the pathological physiology in any given condition, disrepute will be brought to any form of treatment no matter how excellent it may be if properly applied. While the clinician is hesitating to advise radical excision of the varices and at the same time is hesitating to advise the injection method because of the paramount question of safety and end results, a veritable army of early as well as late sufferers from this condition is allowed to grow continuously worse regardless of the palliative measures employed. This paper is presented to bring these newer facts before you that may help you to decide in behalf of the best interests of such patients and to review the results obtained in a series of cases treated in the Dispensary of Washington University.

## HISTORY

The obliteration and cure of varicose veins by the injection of sclerosing solutions into their lumen is not the recent discovery that its rather sudden and popular use would lead one

to believe it to be. Although it is within so brief a time as the last 2 or 3 years that this method has been brought into such practical use as completely to supplant the operative treatment wherever it has been tried, yet as long ago as 1845, soon after the method of syringe injection was introduced by Rynd and popularized by Pravaz, the treatment of varicose dilatations by obliterating injections was attempted. These attempts by Chassaignac and Pravaz by means of ferric chloride, by Valette, by means of the iodotannic liquor, and of Schiassé, by means of red mercuric iodide, are a matter of record. Each of these solutions proved to be extremely irritating and caustic. Also at this time the doors to the true science of bacteriology and pathology were just being opened by the epochal work of Pasteur and Virchow and asepsis was still unknown. In consequence, the method failed and was abandoned due to the resultant sloughs and infections with their associated hazardous complications, such as thrombophlebitis, gangrene, embolism, and septicæmia.

Antedating even this, for as long perhaps as mankind has existed, nature has attempted by the same means to rid the sufferer of his varices by the method of septic thrombophlebitis, which differed in no appreciable way from the manner in which the injection method was first applied except in that the former was accidental and the latter induced. It is not uncommon still to treat many patients in the dispensary for bacterial thrombophlebitis, the result of varices neglected by years, followed by hæmatogenous infection of the traumatized vein or an infection from without through a break in the skin. The exciting agent, in this instance bacterial, is not primarily sclerosing in character, but rather suppurating, liquefying and propagating in its action on the vein wall and the loosely separated clot within. Under the most ideal circumstances and with



Fig 1

Fig 2

Fig 3

Fig 1 Advanced generalized involvement of the great saphenous system of both legs in female aged 36 years. Communicating veins are entirely competent. No secondary tissue changes.

Fig 2 Same patient as in Figure 1, 5 weeks later after 3 weeks' treatment with five injections of sodium salicylate, three of which were given in left leg and two in right. Note partial disappearance of veins.

Fig 3 Same patient as in Figure 1, 5 months after first picture. Received no further treatment other than that given before Figure 2 was taken. Note the complete atrophy of the veins with puckering of the stretched inelastic skin that once covered the varices.

the most intelligent care this condition is most hazardous to life and permanently invalidating for the remainder of life if the deep veins become involved. If, however, after a long and tedious convalescence, the patient recovers, the final result, too, is permanent obliteration of the diseased veins by organization and fibrosis and the patient may be improved ever after provided the involvement was not too extensive. So we have illustrated here in the very complication of varicose veins which we hope to avoid, an age old suggestion by nature of the treatment that we now have thoroughly in our control and can apply with precision and safety.

The method remained forgotten until 1911 when it was noted that certain solutions used intravenously in the treatment of disease caused obliteration of the veins without inflammation, pain, or embolism. Blum made the observation with sodium bicarbonate in the treatment of diabetic coma and P. Linser with mercuric chloride in the treatment of syphilis. Sodium bicarbonate required several

injections and was indefinite in its results. Mercuric chloride was used reservedly by Linser for the obliteration of varices until 1922 when its guarded use was abandoned by him in favor of sodium chloride, due to the toxic properties of mercury.

Between 1911 and 1921, however, this method enjoyed its true renaissance, as it remained for Sicard to rediscover the rationale of this treatment during the war when he noticed that certain alkaline solutions injected into the veins of the elbow brought about their obliteration painlessly. Researches were then carried out by Sicard, Paret, and Forestier with the idea of applying this property of alkaline solutions to the treatment of varices. As a result, in 1920, sodium carbonate 20 to 40 per cent in small amounts was recommended. This proved to be too caustic and in spite of its excellent sclerosing properties is now only of historical interest, the slightest drop outside of the vein causing necrosis of the skin. In 1921, Sicard began the use of sodium salicylate, which he found much less caustic and

equally efficient in its results. By 1924 Sicard's results showed thousands of injections with sodium salicylate without an embolus. The method, which is now popularized in France, was not slow to spread into the clinics of England, Sweden, Austria, and of this country as well.

The next paper that justly received almost universal consideration because of the large experience it embraced was that of Forestier in 1928 in which more than five thousand injections without a fatality or embolus are reported, various solutions being used which meet the requirements satisfactorily. It is out of the work of this French clinic that the present injection method of treatment has received such sudden enthusiastic and universal acclaim in these few years that have followed.

There followed reports from representative clinics so favorable and, in each instance, so superior to the operative treatment that the use of this method was begun in the Washington University Dispensary in July, 1928. During the first 15 months, 104 consecutive cases were completely treated. No surgical operation for varicose veins has been performed at Barnes Hospital since the injection treatment was initiated.

#### ETIOLOGY

In speaking of varicose veins through this presentation, it should be construed as meaning only varices of the lower extremity which constitute the clinical entity with which this paper is interested. It is the great saphenous system with the longest superficial vein in the human body, that is most frequently involved. The smaller saphenous system may present the greater involvement occasionally but most often takes a lesser part in the complete picture.

Of the 104 cases completely treated, 27 (26 per cent) were males and 77 (74 per cent) were females. Their ages ranged from 21 to 74 years averaging 46 years for the series. Varices occurred in both limbs of 54 (52 per cent), in the right limb only in 26 (25 per cent), and in the left limb only in 24 (23 per cent) of the cases. Thus a total of 158 limbs were treated.



Fig. 4, left. Localized advanced varices associated with incompetency of communicating veins. Note advanced secondary tissue changes with small ulceration.

Fig. 5. Same patient as in Figure 4, 3 months later after treatment with two injections of sodium salicylate. Varices are atrophied and ulceration is healed.

In 72 (60 per cent) the condition was advanced and generalized in one or both limbs. The duration of the varices varied from 1 to 40 years with an average duration of 12.7 years. Ulcer was present in 51 (49 per cent) of the cases with a duration of 1 to 20 years and an average duration of 3 years.

There is a greater frequency among females and a tendency to involve both limbs, though neither limb appears predisposed when only one is involved. The striking thing is that the long average duration of both varices and ulcers illustrates how poorly we have had this condition in our control in the recent past. It will also serve to contrast the helpless plight of the varicose vein sufferer, which characterized his past, with the bright future which is destined to come for him out of the alert and early application of the injection method.

The reason for the great prevalence of this condition is found in the fact, that as human beings, we are all predisposed primarily to varices by virtue of our upright standing posture. If this were not maintained, the other etiological factors would produce a negligible effect.

Next in importance, endocrine insufficiency would seem to bear more than a contributory relationship to this condition. The varicose diathesis, a state of fragility of the walls of the veins that predisposes them to expansion under pressure, has been mentioned in the



Fig 6 left Man 63 years old with generalized varices of left leg and marked secondary tissue changes with edema and ulceration and deep induration encircling the leg

Fig 7 Same patient 3 months later with varices atrophied ulcer healed and edema disappeared

literature. Thus there are certain individuals who appear inherently predisposed to varices. There is a history, in such cases, of varices in their family through one or more past generations. It occurs in both sexes, but in girls most frequently, most conspicuously at the age of puberty and progresses slowly and independently from then on as if by its own tendency to progress rather than as the result of a continuation of the original cause. The onset of varices in women is closely associated with pregnancy. Twenty, or 52 per cent of the 38 cases who had born children in this series, gave a definite history of onset at the time of pregnancy. Failure to note this in many of the records would probably indicate a higher percentage of relationship. It is frequently observed that varices begin to form as early as the second and third month of pregnancy when intra abdominal pressure has not yet increased. During the early puerperium, the varices gradually become less conspicuous and the vessels regain their tone. In subsequent pregnancies, the condition advances to a greater degree each time, until finally there remains no ability for the vessel to contract and the varices are permanent and progressive from then on as an independent condition. In 2 patients after the ninth and thirteenth pregnancy respectively, although

noticing the onset of varices in their fifth pregnancy, there was a sudden gain of 70 pounds in weight concomitant with equally as sudden an advance of the varices to a tremendous size. Where they were localized before, they suddenly became generalized to involve all the superficial veins of both legs and thighs. Both of the patients were about 5 feet tall, in their thirties, weighed between 220 and 240 pounds on admission and presented an endocrine insufficiency syndrome. In both puberty and pregnancy other evidences of endocrine insufficiency have been noted as in the transient enlargement of the thyroid gland along with changes in the emotions, vitality and activity of the individual. Likewise the state of the endocrine system plays an undoubted role in the hereditary tendency to varicose veins as well as in the etiology of varices associated with pregnancy and puberty by determining the state of strength or tone in the musculature of these veins. Since dilatations in the venous system have been frequently noticed in association with acromegaly, an insufficiency of the pituitary gland has been considered by Sicard, Gangier, and Forestier. They have combined pituitary therapy with local treatment. Forestier states that varices accompanying pregnancy are not due as it was first assumed, to the compression of the pelvic veins through the dilated uterus but to transitory troubles of the endocrine glands which tend to disappear after delivery.

Contributory causes are as follows. Occupations requiring standing in one position thus losing the pumping action of the muscles of the leg on the deep veins (mail carriers though on their feet much of the time are said to be relatively free from varices) anything raising the intra abdominal pressure as repeated straining or coughing severe lebric disease associated with marked general asthema in which the musculature of the vein wall becomes atonic and dilates as soon as the patient stands (one case occurred after typhoid fever, another after 5 weeks in bed following removal of a pus appendix in both instances the varices occurred in both limbs soon after standing and were associated with no other symptoms in the venous system), tight elastic

about the limb, especially in the warmer months when smooth muscle tone in the surface of the body is unusually lax. However, mechanical obstruction appears to play a minor rôle in etiology.

#### ***PATHOLOGICAL ANATOMY AND PHYSIOLOGY***

There are no valves in the venous system between the opening of the inferior vena cava into the heart and the saphenofemoral junction. Normally, the venous pressure is greatest throughout the body in its periphery and lowest at the heart. In the saphenous system, this condition is not only true, but in addition, a hydrostatic pressure proportionate to the distance between the heart and the level of the feet, is acting in increasing amounts at the lower levels regardless of the condition of the valves. This pressure is transmitted through the successively lower segments of vein, with the valves perfectly competent until the greatest effect of the hydrostatic factor is experienced in the lowest segments.

In occupations and disease that cause an increased intra-abdominal pressure from straining or coughing, the venous pressure is greatly increased throughout the body. While the stronger first sets of valves in the thigh would seem to feel the brunt of this, yet the pressure is even greater at the lower level and the transmission of this added increase in pressure, repeated frequently, gradually forces the valves and the walls of the veins of the leg to stretch, with final incompetency of the valves. The statement usually found in representative textbooks, and which is made so recently as in one of our late systems of surgery, that the varicosity forms from above downward by the breaking down of the first set of valves in the thigh and followed successively by incompetency of the lower ones, is not borne out by observation or the physiology involved. Varices are seen most frequently and earliest in the veins over the inner aspect of the calf of the leg where the veins, by nature of their thinner walls and weaker valves, first suffer from the factors that are at work.

The condition then progresses slowly or rapidly depending on the degree of retrograde flow in the involved segment. If this be great,



Fig 8, left. Marked bilateral varices of both legs with extremely advanced superficial secondary tissue changes. Note ulceration on dorsum of left foot and between the toes. Symptoms of stasis and engorgement of subcutaneous tissue and skin were intense in this instance so that the patient was unable to walk about.

Fig 9. Same patient as in Figure 8, 2 months later. All veins are atrophied. Ulcerations are healed though still crusted. Symptoms have all disappeared. Patient walks with complete comfort again.

the support from under the valves above is removed and they break down successively from below upward until the entire great saphenous system is eventually involved.

Normally the circulation in both the superficial and deep veins of the lower extremity is directed to the heart. This is accomplished in the standing posture by the rigid support given to the deep veins by the muscles and fascia lata surrounding them and by the valves in both these sets of veins and their intercommunicating veins. These valves prevent back flow from the higher levels and are so placed in the communicating veins that the blood flows from the superficial system to the more active deep system in times of strain. There are four to six such communicating veins in the leg and they act as a check valve on the pressure in the superficial system.

In the great saphenous system which has become varicose and has lost its valves, the circulation is static in the recumbent and retrograde in the standing positions. The blood flows from the superficial veins of the leg, through the communicating veins, up the deep veins, and is spilled over again into the great saphenous vein at its femoral junction. So long as the communicating veins remain





Fig. 10. Ulceration and sclerosis so advanced as to involve all soft tissues down to the bone and surrounding the entire lower half of leg. All veins obliterated with improvement in ulcer to stage pictured beyond which no further healing can be made to occur by any means known.

competent, immense varices may be present without appreciable change in the nutrition of the leg. Swelling is usually negligible if any, and no ulcer or pre-ulcerous condition occurs. The symptoms which may be present are usually quick fatigue of the legs, tense aching, dragging sensations, and some itching of the skin.

This condition is not destined to continue long, however, in any given case. With the overwork of the deep circulation and the constant increased pressure within it, the valves of one or more of the communicating veins break down, which then produces a focusing of stasis in this area both from within and without. The changes consequent to this are oedema and pigmentation of the skin, followed by a slow sclerosis of the part which is common to all malnourished tissue. Ulceration may form early or late in such an area, depending on the degree of stasis and the amount of care taken in prevention.

This is explained why so few symptoms and no ulceration may accompany severe advanced varices over the entire limb, while more local varices may be associated with most advanced secondary tissue changes. The competency of the communicating vein sup-

plying a given area is the all important factor after varices have formed. It has been the experience of all surgeons who have performed many radical excisions of varices together with excision of the ulcer, to have found a tremendously dilated communicating vein extending inward from beneath the center of the base of the ulcer. Certain tests will be described later that conform, in the information they give, to this operative finding.

Thus the effect, as well as the curative failure, of elastic stockings is also accounted for in the relief of ulcers, while none of this elastic support is usually used or required without these secondary changes present. Due to this elimination of the portion of stasis caused by the superficial varices, the ulcers and other secondary objective and subjective manifestations improve, but not in proportion to the amount of superficial stasis relieved, because the incompetent communicating vein continues to be unaffected by this measure and drainage of the part is very little improved.

The deep veins are almost never varicose and their insufficiency is most rarely a part of the picture described, the result of any of the factors so far mentioned. This is accounted for by their anatomical relationships. When insufficiency of the deep veins is present, it is due in most every instance to a previous pyothrombophlebitis, causing a condition known as *phlegmasia alba dolens* (milk leg). The condition is quickly recognized, usually without tests, by the continued unremitting swelling of the ankles and legs dating definitely from the occurrence of the acute condition after pregnancy, typhoid, or septicæmia from other causes. The symptoms and signs are always more striking and persistent and out of proportion usually to the superficial varices present.

However, a test may be applied to confirm the diagnosis of the deep circulation. No other test used affords any direct information concerning the deep veins. A well fitting elastic stocking is worn or an elastic bandage is applied firmly, so that all the superficial veins of the leg are closed by the pressure. The patient is told to walk continuously for 30 to 45 minutes. If the deep veins are incompetent,

obstructed, or closed off from some pathological condition within them, a sufficient portion of the return circulation is thus cut off to cause a decided aggravation of the symptoms and in some cases violent pain. If no discomfort is experienced with the bandage, one may be sure the deep veins are functioning properly.

The Trendelenburg test does not reveal the condition of the deep veins, as was generally believed, but rather the condition of the communicating veins, and, therefore, does in no way decide for or against treatment of the varices. The patient's limb is elevated in the recumbent position until the superficial veins are emptied of blood. With a tourniquet applied high around the thigh so that the veins only are compressed, the patient is asked to stand. If the veins fill up suddenly from below, the communicating veins are incompetent. If they fill suddenly with a gush, only after the tourniquet is removed, incompetency of the valves of the great saphenous vein is demonstrated as is also the retrograde flow of blood within it. With ulcer and other advanced soft tissue changes the first result is invariably obtained and is no contra-indication to obliteration of the superficial varices as was formerly taught. It is rather an added indication for their treatment.

A striking test, first described by Perthes, is also used to demonstrate the condition of the communicating veins. With the superficial veins dilated and distended in the standing position, a tourniquet is applied about the upper thigh, sufficiently tight to compress the surface veins (30 to 50 millimeters of mercury). The patient is asked to move up and down on the toes 20 to 40 times. If the varices diminish in size, competency of the communicating veins, as well as the deep veins, has been physiologically demonstrated. Removal of the tourniquet then allows the blood to flow downward to distend the varices again. This first and positive result could be demonstrated in all cases showing no signs of advanced stasis, but the test revealed a negative result when applied to patients presenting old ulcers and large chronic indurations. In either case the varices are treated in the same manner if the deep circulation is normal.



Fig. 11, left. This pictures one of the two patients described with etiology associated with endocrinopathy of pregnancy. The patient is 40 years old, weighs 250 pounds, and is 5 feet tall, has had 13 pregnancies, suddenly gained 70 pounds weight after last pregnancy at which time all the superficial veins over both limbs became varicose. The ulcer is of 1 year's duration.

Fig. 12. Same patient as in Figure 11, 6 months later. Treatment was completed after paper was submitted for publication. The several varices at upper margin of ulcer were injected first. The ulcer became dry and free of exudate at once and healed in 4 weeks with no special care. A total of 45 injections were necessary to close all of the varicosities that covered all portions of both limbs. Endocrine therapy was begun at once and has continued to date. All symptoms of varicose veins have disappeared, the patient has lost 40 pounds weight, and no more subjective symptoms of endocrine deficiency remain. Not the smallest varicosity remains over this patient's limbs, a result unobtainable by any other method.

#### PATHOLOGY

Whether from a primary dilatation of the vein wall or a primary breaking down of the valves, depending on the etiological factors, the changes in the vein that accompany varices are the same. The vein becomes gradually more distended and the wall more stretched until, due to malnutrition of the wall, the muscle layer disappears. The stretching occurs longitudinally, as well as circularly and the vein becomes a sacculated, fibrous walled tube.

This scarring and stretching of the vein blends imperceptibly with the areas of secondary indurations about it so that in advanced cases the only vein wall which remains is that which forms a roof over its canalizing burrowing passage through the indurated area. Even here, the entire lumen is lined with endo-



Fig. 13. Table designed by us for the injection of varicose veins. Its use has simplified the treatment greatly. It has advantages over other tables described in that the patient stands during the insertion of the needle which remains connected to the syringe containing the fluid during the entire operation. Veins on the thigh and posterior aspects of thigh and leg are thus readily accessible. The center of gravity is placed so that the patient is changed from the upright to the recumbent position by one hand of the attendant. The patient does not move a muscle or change position during the operation. This shows the table in the vertical position ready for insertion of needle with veins distended.



Fig. 14. Table in horizontal position. The change is regular and steady so that the position of the needle is not disturbed. Injection is made in this position. Thus the technique is rendered neat and accurate for varices anywhere on the lower extremities.

#### CONSIDERATIONS IN TREATMENT

thelium, though the edges of the vein are marked only by the sharp precipitous edges of the scar tissue about it.

The complications of varices are all manifestations of venous stagnation followed by chronic malnutrition. Skin changes are among the earliest and are represented by a scaly atrophic condition, hyperkeratosis, and in some cases an active eczema. Moderate edema is common. The soft tissues become indurated by diffuse fibrosis. Ulcer either forms spontaneously over this, or as the result of a slight trauma. The favorite site of ulceration is a few centimeters above the internal malleolus. Its course is usually very rapid due to the poor resistance in this preulcerous area. Cellulitis in varying degrees of acuteness often develops and the infection may continue on into a phlebitis of the superficial veins. A periostitis may be present over the tibia or fibula with or without ulcer.

In early cases when certain contributory causes are discovered, these should be removed. Endocrine dysfunction should be treated if possible. It is in these early cases that the injection treatment finds a field of usefulness shared with no other method of treatment before known. The patient with the first localized patch of varices in the leg naturally refuses operative removal of these when told others may form. They do not as yet cause symptoms and the patient is quite willing to wait until they do. Palliative measures only retard in a small way the inevitable progress of the condition. The next time a physician is consulted, it is usually for the complications of an advanced stasis and after the insidious tissue damage has become irreparable. The prevention of all the complications of varices lies within the province of the injection treatment by relieving the patient of the varices as they occur or as they may be discovered in our routine examinations.

In the late cases, operation is often impossible because of the advanced malnutrition of the lower half or two thirds of the leg. It is true that all the varices in these cases may be obliterated by the injection method and the ulcer not heal completely. The local tissue change has advanced so far as to become a permanent condition independent of the varices. In these cases, improvement always occurs, however, commensurate with the re-

lief of venous stasis and the degree to which it still influences the picture. Often in such cases, living is made bearable again where amputation was the only alternative in the way of operative treatment.

Between these two extremes lies the greatest number of patients for whom the veins are disfiguring or who are suffering in varying degrees from the presence of varices. In this group all but the traces of secondary complications disappear and the ulcers heal as if by magic under the injection treatment. Economically the treatment has its advantages. The patient need lose no time from his activities and there is no hospital expense. The absence of a scar gives a perfect cosmetic result. The varices successfully treated can never recur, although others may form in other veins later, just as it was the tendency of the patient to form the first ones. These may be treated as they occur. In the meantime the extremity has been protected from the complications of stagnation which would have progressed.

The contra-indications to treatment by the injection method are few. Obstruction or incompetency of the deep venous return with its associated extensive edema definitely contra-indicates injection. Not only will the already severe symptoms be made definitely worse, but the danger of gangrene following is great.

Active thrombophlebitis contra-indicates treatment only until all symptoms and signs have disappeared according to some workers. In the experience of others, 10 years should be waited after the last exacerbation before injecting the veins. When it is considered that 7 of the 11 deaths reported in association with this treatment were due to emboli from a bacterial thrombophlebitis, it makes one over-cautious. It is much more logical and safe to refuse treatment to the occasional case presenting this condition, than to take a chance on so violently activating an old phlebitis.

For the same reason focal infection should be looked for and if present eliminated before injection. The injury to the vein wall by the injection definitely lowers its resistance to metastatic infection and a bacterial thrombophlebitis may ensue.

In pregnancy, at least 3 months should

elapse after delivery before injection is done. This will allow for as much natural involution of the varices as is possible.

Diabetes should be treated before work on the veins is begun.

Collateral varices, such as are seen extending up over the abdomen from the circumflex tributaries of the saphenous vein, indicate an obstruction to the inferior vena cava or the iliac veins and definitely contra-indicate any treatment by injection. The flow in these veins is active and to the interest of the individual.

Arterial disease of the extremities such as Raynaud's disease, thrombo-angitis obliterans, and endarteritis are conditions which should receive primary consideration in treatment as their symptomatology will overshadow any symptoms of the varices.

Several patients over the age of 65 were treated in this series and stood the treatment perfectly. A careful physical examination should be made in all cases, however, before treatment is begun to ascertain signs of debility, cardiorenal disease, focal infection, and the possibility of venous obstruction in the pelvis.

#### TREATMENT

**Solutions** Solutions which coagulate the blood are dangerous and should not be used. One death is reported with Pregl's solution which comes under this group. Destruction of the intima is the property of solutions desirable in this treatment.

Of all the mineral substances that have been found capable of obliterating the varices, sodium chloride, glucose, quinine and urethane, and sodium salicylate have won greatest favor. Forestier still reports the use of red mercuric iodide in some of his cases.

Sodium chloride in 20 to 40 per cent strength is popular with some workers. Injections are quite painful and the danger of slough formation more marked than with other solutions.

Greensfelder reports tachycardia and cardiac irregularities in one patient 60 years of age, following each injection of 5 cubic centimeters of 20 per cent sodium chloride solution. He concludes that patients of advanced years with slight tendency to cardiac irregularity may be adversely affected by sodium chloride

injections Of the 10 fatalities in association with this treatment, as reported in McPhee-ter's review of the literature, sodium chloride was used more than any other solution and sodium salicylate in none This is in all prob-ability only a coincidence, since in all of these cases but one, death was not directly due to embolus formed by the injection, but rather due to localization of the infection already present in the patient, or to the introduction of infection from without causing a secondary bacterial thrombophlebitis with embolism

Invert sugar is used in 50, 60, and 75 per cent strengths, 5 to 10 cubic centimeters per injection There is no sensation of discomfort at time of injection Results in this series were very irregular and not dependable In 9 patients 10 cubic centimeters of 75 per cent invert sugar were injected with 6 failures and only 33 per cent success The solution is thick as a syrup in this concentration and is difficult to force through the fine needle Its stickiness renders it unpleasant to work with However, in the only injection in which sodium salicy-late failed, invert sugar succeeded in obliter-ating the vein in one injection So it is of definite value in a small per cent of the cases Greensfelder, using 20 per cent sodium chlor-ide and 50 per cent glucose in dogs, obtained only 20 per cent successful thrombosis with glucose as compared to 100 per cent success with sodium chloride In our experience, in solutions weaker than 75 per cent, invert sugar is not efficient enough to warrant its use, while in 75 per cent strengths it is a valuable adjunct in the treatment of certain cases Glucose is contra indicated in diabetes

Quinine hydrochloride and urethane must be used in amounts not exceeding 6 cubic centimeters in the concentration necessary Even so, quinine idiosyncrasies warrant its guarded use Also, its efficiency is limited be-cause of the small amount which may be safely injected since the amount of vein obliterated depends quantitatively on the length of vein wall which may come into contact with the solution in proper concentration

Sodium salicylate has proved so efficient dependable and safe that we have used it in preference to all others in our work It is used in 20, 30 and 40 per cent strengths in amounts

from 5 to 30 cubic centimeters per treatment In no instance at any age did symptoms of salicylism occur, other than an occasional statement that the drug could be tasted when the larger amounts of the stronger solution were used There is a burning stinging sensa-tion through the veins as it enters and this is sometimes followed by a cramp in the calf muscles This all passes away suddenly within a minute of its onset In nervous hyperemo-tional patients who react to pain poorly, an hysterical collapse may occur, but in no instance did complete syncope follow When explained to such patients that pain, in itself, can do no harm and that, in this instance, it results in a definite benefit, they are quite willing and anxious to receive further injec-tions Many patients give no indication of this brief discomfort The complications resulting from sodium salicylate are minimum The veins become slightly painful and tender to pressure and remain so during the time that the changes most actively occur in the process of its obliteration In our experience slough-ing does not occur if a few drops of the 20 or 30 per cent solution escape into the tissues McPheeters mentions the possible idiosyn-crasies to it similar to that to quinine and states the maximum dose in any case should be 3 grams In this series there has been no indication of idiosyncrasy thus far and doses up to 8 grams have been given with no inten-tion of going higher In all the literature, no fatality has been reported in association with the use of sodium salicylate although it has been used more than any other solution in by far the greatest number of cases treated, due to its favored use in the French clinic of Sicard and Forestier

*Technique* The area over the vein to be in-jected is cleansed with iodine and alcohol With the varices distended in the standing position, a 23 gauge needle on a 10 cubic centi-meter syringe is inserted into the varix at its lowest point above the ankle The needle must be very sharp or difficulties will arise If a drop of blood is easily drawn or runs into the syringe, the latter is disconnected from the needle and the patient is put in the re-cumbent position After the varices are emptied of their blood by a slight elevation of

the leg, the fluid is drawn into the syringe and the syringe reconnected to the needle (This disconnection during change in position of the patient is to safeguard the position of the needle in the vein during the irregular maneuvering of the patient. A special table is being constructed at present by which the patient will not be required to move a muscle between the standing and recumbent positions. This step will then be eliminated in the procedure.) Again a trace of blood is easily drawn into the fluid to be sure of the needle's position in the vein and with the heel of the foot held about 6 to 8 inches above the level of the table, the fluid is injected rather quickly, but without force, into the collapsed varix. An alcohol sponge is placed firmly over the site of injection and bandaged into place by 3 inch gauze which lightly covers the leg and maintains a collapse of the varices. The patient is allowed to rest for 30 minutes without moving a muscle of the leg. The patient may then go home and about his duties, and is instructed to sit down and keep the leg elevated whenever possible during the next 24 hours. The bandage is removed the following morning by the patient in his home. Injections are best made not oftener than every 48 hours at which time as much thrombosis has occurred as will. The next injection is made just above the level of obliteration obtained in previous injections.

*Explanation of principles* No veins of the foot are injected because of the irritation of wearing a shoe over the resulting thrombotic masses which would project above a non-resilient surface. Also, the communication between the superficial and deep veins of the foot is most freely active and the danger of obliterating both deep and superficial systems is great. The varices of the foot give little trouble after the great burden from above is removed and many of them undergo atrophy.

If the fluid cannot be injected without appreciable force the patient will quickly complain of intense pain and burning at site of injection indicating the needle is out of the vein and the fluid in the tissues. Since only a drop or two of the fluid causes this, no injury results. It is best to select another vein en-

tirely for injection after the vein has once been entered and lost.

Fluid may escape into the tissues through the opening in the vein around the needle in very thin and superficial veins. This usually causes a small dry black eschar of the skin with a mild cellulitis beneath. This can be prevented when suspected, by infiltrating the tissues with physiological normal saline. Infiltration of the tissues with the fluid can be detected readily by placing the finger of the other hand over the point of the needle as one injects. If the tissues remain soft and the vein, filled with fluid, remains discretely palpable, the injection is continued with confidence. To wait for blanching of the skin and oedema to appear because of fluid in the tissue is unnecessary and unwarranted.

No tourniquet is used above or below. The firm solid separation between the superficial and deep systems which is furnished by the fascia lata and muscles within is sufficient to keep the fluid in the path of the negative resistance peculiar to the superficial varices. The fluid injected is of such amount that it does not begin to equal the capacity of the varices.

The recumbent position is maintained for 30 minutes to keep the fluid in the varices as long as possible. Absence of muscular action prevents it from being pumped into the deep veins. As the fluid gradually dissipates itself into the general circulation, it becomes diluted beyond effect. If it retains its sclerosing concentration for the full length of the saphenous system, it immediately is diluted as it enters the femoral vein by the blood as it actively passes the saphenofemoral junction with no possible effect on the femoral vein.

No more than one injection is made into a single varicose system in one treatment. As many as five injections, each into varices which do not anastomose freely, has been made in one treatment.

The strength of the solution used depends on the type of varix treated. The 20 per cent solution is efficient in early cases in which the vein wall has not undergone advanced fibrous changes, also when the nutrition of the vein and tissue immediately about remains good.

In advanced cases, with marked secondary tissue changes and where the vein wall is thin and atrophic, the reaction to the solution is reduced, and up to 40 per cent strengths must be employed. Experience quickly teaches one the strength of solution indicated in the various types of veins in any given case and thus reduces the number of failures due to injection of too weak a solution.

Where the varices are immense and generalized, with an enormous capacity, and are intercommunicant by large sinuses, then the larger amounts of solution are used up to 20 cubic centimeters of 30 per cent in one injection. Often, in such cases, the entire varicose system will be thrombosed up to the femoral ring in one injection, with no further treatment necessary.

*Mechanism of action.* Forestier describes very accurately the pathology in the vein resulting from injection which causes the final fibrous obliteration of the vein. Three degrees of reaction were also found to occur in this series. First, a simple thickening of the vein wall without obliteration occurred in a few instances where too weak a solution was used. Second, complete occlusion of the vein without perivascular reaction occurred in the majority of instances, in which the vein presents a solid cord without inflammatory signs, 24 to 48 hours after injection. Third, complete occlusion with perivitis occurred in a few cases especially reactive to the solution. The irritation extends through all three coats of the vessel and into the soft tissues beyond. The area about the vein is painful, swollen, somewhat indurated, pink in color, and possesses increased surface heat. Irrigation with cold applications relieved the transitory inflammation in each instance within a few days.

The sclerosing fluid has no coagulating action in the blood, but due to its caustic action on the intima, causes an injury to the endothelium varying from an irritation to a necrosis of these cells. Congestion, a mild exudation, and all the early signs of inflammation follow. The exciting agent having passed on and disappeared entirely, the forces of the blood are not called upon to destroy infection as in bacterial thrombophlebitis, but mobilize merely to heal the injury done

Fibrin is deposited on the walls of the injected vessel. The regular process of thrombosis follows until the lumen of the varix is obliterated. This usually occurs within the first 12 hours and often as early as the first hour after injection.

According to experimental work done by Greensfelder on dogs, the thrombus is hyalinized in 3 days, fibrosis is well begun in 7 days, and advanced organization is present in 14 days. Polymorphonuclear leucocytes appear in the subendothelial layers in the early stages, but the process early and quickly changes from that of an acute inflammation to one of healing *per primam*, due to minimum of injury and the absence of further irritation, chemical or bacterial. The adhesive qualities of the fibrin in the absence of infection between thrombus and vein wall, make of the entire cross section a confluent solid mass, with organizing granulations rapidly moving inward from the periphery, finally to convert the whole into a solid contracted fibrous cord. The thrombus can only form where vein wall is injured and cannot propagate because of the absence of bacteria or other irritants necessary to such a process.

Compare this with the picture of bacterial thrombophlebitis, with its purulent reaction, its bacteriolytic and cytolytic, its liquefaction and separation between clot and vein wall, the propagation of the thrombus indefinitely because of the bacterial irritant within, and the impossibility for organization and healing until the pent up infection is destroyed. Then we realize that the results of injection possess none of these qualities and likewise none of their fears.

There is always a theoretical danger of embolus in the injection treatment, but an analysis of the pathology reveals the reason it has not proved a practical danger.

The process occurring in the vein following injection bears the same relation to a thrombophlebitis as an operative wound healing by first intention bears to one healing by suppuration. In the former there are no signs of inflammation or discomfort other than those which accompany the early adhesive organization of healing. In the latter, however, suppuration and all the signs and symptoms of

inflammation occur with separation of the wound edges

This difference in pathology is likewise seen in the clinical pictures related to the veins. The reaction in the vein following injection, which has been designated by Forestier as "venitis," is localized in a selected segment of functionless vein, develops a very adherent clot, gives rise to no pain, general oedema, or other inflammatory signs in the limb, does not propagate beyond its original limits, and finally remains as an atrophic fibrous cord.

In phlebitis, the infection and thrombosis frequently spreads to the deep veins causing painful oedema and cellulitis, the clot remains separated from the vein wall by increasing amounts and propagates into the lumen beyond, and the vein does not atrophy, but tends to remain hard, bulky, and a locus of chronic infection which predisposes to further attacks. That the fear of embolism, as experienced with phlebitis, is not in accordance with the pathology of venitis which positively has no tendency to embolism is a conclusion corroborated by all workers with this treatment.

#### RESULTS

In 104 cases treated by this method, 417 injections were given, an average of 4 injections per case. In many early as well as advanced cases, one injection obliterated all of the varices in the one extremity. In one case 14 injections were necessary to effect a cure in both limbs. Invert sugar in 75 per cent solution succeeded in the one injection where 40 per cent sodium salicylate failed. All of the varices in every instance were obliterated and disappeared. Some remained prominent and sensitive in their hardened state for several months, but disappeared in time.

Only one case failed to show improvement in symptoms. In this elderly patient, the soft tissues of the entire body were extremely flabby and veritably hung in sacculated masses from the bones in any position. It is likely that this case represents a rare condition of a varicose incompetent deep circulation due to lack of muscular support. The oedema and pains in the ankles continued in the same degree after all the superficial varices had disappeared. Elastic stockings benefited this

patient none whatever and a poor deep circulation should have been suspected.

In this series 49 (96 per cent) of the 51 ulcers present were healed during or soon after the treatment of the veins. The two ulcers which failed to heal showed definite improvement up to a certain point, but had advanced to a state independent of the varices which had originally caused them.

Of the complications which resulted, perivitis occurred in 7 or 16 per cent of the cases. This disappeared in each instance in from 4 to 14 days after its occurrence with no special care necessary. A slough was obtained in 2 or 0.4 per cent of the cases. These occurred among the first cases treated when the technique was not yet well perfected. In each instance, liquefaction undermined the indurated skin about the vein for 5 to 8 centimeters distance. The vein wall, resistant to liquefaction, became a foreign body. The cavitated area was opened widely and the free segments of vein removed from its center with subsequent rapid healing.

No septic phlebitis nor signs of embolism occurred in any of the cases treated. Infection is not so likely to be introduced by proper technique as it is to develop following a recent thrombophlebitis or from metastatic infection from a distant focus.

Improvement either in appearance, symptoms, or both is so striking, and in many instances after the first injection, that these patients return to the clinic the most enthusiastic and grateful for the relief of what before meant either operation or daily suffering for them.

McPheeters has published a statistical survey in which of 6,771 surgical operations for varicose veins, 35 postoperative deaths from pulmonary embolus occurred, or 0.53 per cent. Of 53,000 cases treated by the injection method, only 4 fatal pulmonary emboli have occurred, or a mortality rate of 0.0075 per cent.

Meisen reports more than 2,000 treated cases without a fatality. Sicard and Gaugier report 120,000 injections in 15,000 consecutive cases with no mortality. Delater reported 890 cases, Douthwaite 2,000 cases, and Genevriev 4,000 cases without a single fatality.



Kilbourne, after a careful comparison of statistics in the two methods of treatment, states that after giving the excision method every possible advantage in the comparison, the mortality rates favor the injection method overwhelmingly. There is no dissension of opinion in the literature on this score.

In the same article Kilbourne reviews the statistics regarding recurrences. In 1,400 patients treated by the excision method recurrences were noted in approximately 30 per cent, after 2 to 5 years. In almost 35,000 cases treated by the injection method, recurrences were noted in only 5 per cent of the cases after 3 years.

Neither treatment is directed to the prevention of forming new varices, but of the two methods after treatment had been completed, these statistics show recurrences with the injection method to be only one sixth as great as with the excision method.

The fact that the injection method can more completely remove all varices present at a given time, where it is rarely possible to do so by operation, probably accounts for this difference in percentage of recurrence.

No recurrences have been reported in this series to date.

Three patients, who had had extensive operations done 5 to 15 years previously, returned because of advanced recurring varices between the scars. They had refused further operative treatment but received the injection treat-

ment willingly and with an enthusiasm commensurate with their memory of the excision method.

#### CONCLUSIONS

The etiology, pathology, and physiology of varices of the lower extremities have been discussed with the idea of explaining the progressive character of this condition and to indicate the essential considerations in treatment. A review of the literature together with experience in 104 treated cases indicates that, with careful asepsis and accurate technique, ever mindful of the contra indications and the principles of treatment involved, the injection treatment of varicose veins can be advised as a safe, economical, and rational method, which may well replace the excision method to the patient's every advantage. Its adaptability to the early case makes it the responsibility of our routine examinations to discover and treat the condition before it becomes advanced. Thus we may hope to reduce in the future, in a large measure, the number of sufferers from the crippling and permanently disabling end results of the untreated condition.

That the treatment may be applied to old and young, rich and poor alike, assures us that we have, at last, a treatment which will reach and relieve the great majority of the sufferers, and through its prevention of associated disability, will prove of real economic value to the individual and the community.

## ACUTE PANCREATITIS

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IT is the usual conception that acute pancreatitis, acute pancreatic oedema, or hemorrhagic pancreatitis, as it is variously known, is an extremely rare disease. Our experience is not in accord with this. The past 5 years have furnished 13 proved cases treated by the senior author. A non-exhaustive search of the literature from 1923 to 1928 yields 232 cases reported in sufficient detail to provide material for analytical study. Schmieden and Sebening, by means of a questionnaire, amassed the total of 1,278 cases operated upon within an 8 year period. The apparently increasing frequency at the present time, the staggering mortality of at least 50 per cent, the unsolved riddle of the etiology, the high index of incorrect diagnosis, and, finally, the lack of unanimity of opinion as to the proper treatment constitute adequate reasons for increased attention to the subject and more frequent consideration of this disease in the differential diagnosis of acute abdominal affections.

## INCIDENCE

The reported cases show a slight preponderance for the female sex (59 per cent). There is an almost uniform distribution throughout the third to the sixth decades. It may occur, however, at the extremes of life. Authenticated cases are on record occurring at the ages of  $2\frac{1}{2}$ , 3, 4, and 7 years, and also as late as 77 years.

## ETIOLOGY

In the general series associated biliary disease was noted in two-thirds of the cases. In our own experience it was found in 71 per cent. This undoubtedly is a minimal figure since the presence of cholecystitis or even cholelithiasis often cannot be determined at the time of operation. Further corroboration of the coincidence of biliary and pancreatic pathology is given by the customary history of gall bladder pain or indigestion for a more or less prolonged period before the acute attack.

In 96 histories providing information upon this point, 62 noted epigastric or right hypochondriac pain of at least a year's duration. Although it is admitted that acute pancreatitis may occasionally arise precipitously without warning symptoms just as perforation of a peptic ulcer may occur without previous indigestion, nevertheless, it is proper to regard the vast majority of cases as extensions of pre-existing biliary tract infections rather than as a fulminating pristine disease. This sequence of chronic cholecystitis and acute pancreatitis is too common and too important to be ignored.

Experimentally the lesion has been reproduced in animals by a variety of methods. To reproduce the lesion we are confronted with two main problems: (1) we must learn the nature of the substance which produces premature intraglandular activation of trypsinogen, (2) we must learn the mode of access of this substance to the pancreas. In an effort to establish the former a variety of substances have been injected into the pancreas or its ducts. Claude Bernard, in 1856, recorded the use of bile in the first of these experiments. Flexner, in 1906, noted that a solution of taurocholate rapidly produced an extreme hemorrhagic necrosis. By the addition of mucin or some other bland substance such as agar-agar, he was able to ameliorate the severity of the lesions produced. He also successfully used solutions of acids, soda, formalin, and zinc chloride. Archibald revived this concept of the protective influence of mucin. He was unable, however, to demonstrate any significant alterations in the proportions of mucin and bile salts in the bile in cholecystitis. In addition, he confirmed the work of Nordman, who demonstrated that the injection of infected bile produced lesions far more consistently than did sterile bile. Brocq used sterile bile. He collected it, however, either during the digestive phase of the animal or following the administration of secretin.

Polya, in 1906, injected duodenal contents or a strongly active trypsin solution with resulting pancreatic necrosis. Numerous investigators have injected pathogenic organisms alone. They have reported only mild disease processes or none at all. Cultural studies have likewise been unconvincing. The process appears to be primarily a chemical autolysis rather than an infection. All of the recorded experiments involve the common factor of trauma to the pancreatic tissue incident to forcible injection. That trauma alone may be the inciting factor is well demonstrated by a case reported by Holmes. A sailor died of typical hemorrhage pancreatic necrosis 3 days after sustaining an abdominal injury in a fall between decks. The only safe conclusions to be drawn from these experiments are that the introduction into the pancreatic duct of almost any irritating foreign substance together with damage to pancreatic cells, traumatic or otherwise, will produce activation of enzymes and consequent tissue autolysis.

Concerning the mode of access of the activating substance, the discussion centers about whether it is by means of the pancreatic duct or by the lymphatics.

Two other routes, namely, direct extension and the blood stream, are conceivable but have seldom been given serious consideration. Deaver (5) reported 2 cases of subacute pancreatic involvement by contiguous extension from a peptic ulcer. The blood stream is generally regarded as only a theoretical source. Nevertheless, certain factors are suggestive. *Pancreatitis* may occur in the course of an attack of mumps. Operative or postmortem verification of this has been reported by Sabrazes, Lemoine and Lapasset, and Farnum. Moreover, McCrac has observed the occurrence of acute pancreatitis as a complication of typhoid, scarlet fever, diphtheria, and smallpox. However, it is noteworthy that abscesses rarely appear in the pancreas in pyæmia.

Opie, in 1903, first proposed the etiological theory of obstruction at the ampulla of Vater with regurgitation of bile into the pancreatic duct. His deductions were drawn from a case of Halstead's in which a large stone was impacted at the ampulla. Mann and Giordano,

in a careful study of 200 autopsy specimens, estimated that the anatomical arrangement of the ducts necessary for the conversion of the common bile and pancreatic ducts into a common channel by an obstruction as postulated by Opie obtains in only 3.5 per cent of individuals. They made further interesting experiments in determining the pressure in the biliary system. The pressures necessary to produce lesions by injections were in excess of any obtained under physiological conditions. This would seem to discredit all the injection experiments previously alluded to by showing that inadequate pressures cannot be obtained. It is to be noted, however, that they used sterile rather than infected bile for their injections. Archibald is a firm exponent of the ductal hypothesis. He mentions three factors: (1) a spasm of the sphincter of Oddi, (2) an increased pressure in the biliary system, and (3) the introduction into the pancreas of bile with an abnormal composition.

Maugent abroad and Deaver, Pfeiffer, and Sweet in this country, are proponents of the lymphatic origin theory. They base their contentions upon (1) the frequent coincidence of biliary disease, particularly cholelithiasis, (2) clinical cures following cholecystectomy and common duct drainage without direct attack upon the pancreas, and (3) obvious deficiencies in the theory of the opposing school. The sequence of events, according to these writers, is lymphangitis of the gall bladder wall, involvement of lymph channels about the cystic and common ducts, lymphadenitis at the head of the pancreas and, eventually, involvement of the gland itself. Graham attempted to demonstrate the feasibility of such retrograde lymphatic extension. After ligation of the cystic duct and vessels, he traced methylene blue injections from the gall bladder wall to the pancreas. The recovery from the pancreas of hemolytic streptococci injected into the portal vein was taken as further confirmation of lymphatic progression. Kauffman, however, in a repetition of the latter portion of Graham's work, demonstrated identical lesions in other organs and regarded it as a bacteræmia.

It may be gathered that no definite conclusion has been reached regarding the exact

mode of origin Jones may be near the truth when he suggests that there are two forms of the disease. A mild variety associated with cholelithiasis of long standing may originate via the lymphatics. The severe form with early massive hemorrhages may conceivably result from ductal entrance of the mysterious novu

#### **PATHOLOGY AND PROGNOSIS**

The original description by Fitz, in 1880, of the pathological details has never been surpassed. Certain features, however, are especially intriguing to the surgeon at the operating table. The brownish peritoneal exudate and the patches of fat necrosis have been widely commented upon. No one, except Linder and Morse, refers to a peculiar greenish tinged oedema of the mesenteric, omental, and retroperitoneal tissues in proximity to the pancreas. We have often observed this. It is encountered in the early cases before hemorrhage and necrosis have developed. Its dissimilarity from any other intra-abdominal lesion is striking.

The influence of advanced pancreatic disease on prognosis is indicated by Table I compiled from the literature.

**TABLE I—PROGNOSIS IN ADVANCED PANCREATIC DISEASE**

Pathology	Cases	Mortality Per cent
None except fat necrosis	4	25
Pancreatic oedema and fat necrosis	42	24
Pancreatic hemorrhage or necrosis or both	61	65
Gangrene	7	71
Abscess	6	33

The small group of cases with abscess are included because they presented acute symptoms prior to operation. Most abscesses present the picture of subacute or chronic pancreatitis.

#### **DIAGNOSIS**

Diagnosis is rendered difficult by the protean manifestations of the disease. The usual textbook description is that of a fulminating abdominal calamity accompanied by profound shock. This, however, fits only one group of cases—the hyperacute variety (Deaver). Not infrequently associated acute biliary symptoms may dominate the picture to the exclu-

sion of the pancreatic syndrome. So bizarre are some of the guises of acute pancreatitis that in the case reports we have studied, a correct pre-operative diagnosis has been made in only 31 per cent. Among the conditions simulated are acute cholecystitis, acute intestinal obstruction, perforated ulcer, and acute appendicitis. Sometimes no other diagnosis than that of an acute surgical abdominal condition is possible. If one believes that immediate operation is indicated in acute pancreatitis, refinements of differential diagnosis are superfluous. The correct diagnosis manifests itself by bloody peritoneal exudate and fat necrosis the moment the abdomen is opened. On the other hand, if one favors an expectant mode of treatment, accuracy of diagnosis becomes essential.

#### **CLINICAL MANIFESTATIONS**

We are indebted to Moynihan for the most picturesque bedside description. There are a few features to which we would call particular attention. It is customarily stated that the pain of pancreatitis tends to begin shortly after the taking of a heavy meal. It is well known that this holds true for gall-stone colic. In those cases in which there is a combination of cholelithiasis and acute pancreatitis a postprandial onset is very likely. However, it is possible to muster fully as many instances where the onset occurs during the night, in the early morning, or while the victim is at work. The point to be stressed is that a post-prandial pain may signify biliary colic but is not diagnostic or even characteristic of acute pancreatitis *per se*.

Certain features of the pain are distinctive. In 27 per cent of the reported cases there was radiation from the primary epigastric location to the back at a corresponding level. Other favorite reference points are one or both shoulders (7 per cent) and the left upper abdomen (6 per cent). The pain is severe with a tendency to remissions. Indeed, Moynihan declares that "of all the pains the human body can suffer, this is by far the worst." Ogilvie makes the interesting differentiating point that "in acute perforated ulcer the patient never moves from the place where the pain has felled him, in acute pancreatitis,

TABLE II—

Case	Age	Gall bladder symptoms	Duration present attack	Location of pain	Radiation of pain	Vomit ing	Shock	Jaun dice	Cya nosis	Glyco- suria	White blood cells	Fat necrosis
1	53	None	6 da.	Epig	Back and scap	+	o	+	?	o	25 700	+
2	59	None	3 da.	Gen	None	+	++	o	+	o	10 900	+
3	47	7 yr	12 hr	Epig	None	+	+	o	?	?	11 000	+
4	55	18 yr	16 hr	Epig	Scap.	+	o	o	+	+	16 900	+
5	37	1 years	2 da	R U Q	Back and chest	+	o	o	o	o	25 300	+
6	53	4 wk	9 da	Epig	Back	+	o	+	o	o	7 800	+
7	65	2 yr	1 1/2 da.	Epig	Back	+	o	o	o	?	19 300	+
8	50	1 yr	7 da.	Gen	None	+	o	o	o	o	19 300	+
9	30	3 yr	24 hr	Epig	None	+	o	+	o	o	23 300	?
10	64	1 years	24 hr	Epig	None	+	o	o	+	o	10 600	+
11	30	3 mo	12 hr	R U Q	Back	+	o	o	o	o	19 000	+
12	38	None	48 hr	Epig	Back	+	o	o	o	o	27 300 49 300	+
13	42	8 yr	6 da.	R U Q	None	+	o	o	o	o	12 700	o
14	52	12 yr	4 da.	Epig	None	+	o	o	+	o	28 700	+

however, he may go to work after the onset." The contrast between the "frozen" attitude of the patient with an acute perforation and the writhing gyrations of the one with biliary colic is well recognized. The patient with acute pancreatitis assumes a position of moderate relaxation, intermediate between these two extremes. It has been our own observation that these patients tend to favor a right lateral decubitus position. Vomiting is a constant symptom. It is usually persistent. Shock is conspicuous in the fulminant hyperacute cases. It may, however, be entirely absent. A distinctive cyanosis limited to the upper portions of the body was first described by Halstead. It is a slate gray rather than the purplish blue tinge of pulmonary cyanosis. When present, it is virtually pathognomic. It was observed in only 40 per cent of 200 reported cases. In 10 others there was a definite statement of its absence. Doubtless, it was often overlooked. Explanations of its origin are interesting, although unconvincing. Some have ascribed it to a reflex splinting of the diaphragm. A similar splinting occurs in

other upper abdominal catastrophes, notably perforated ulcer, but does not in these instances give rise to cyanosis. Others attribute the phenomenon to a torsemia analogous to that sometimes seen in terminal sepsis. Neither of these explanations is adequate. Nevertheless, the presence of cyanosis is to be regarded as of grave prognostic significance. Where this sign was noted, there were only 6 recoveries in the 40 instances, including several of our own.

The abdominal signs are not proportionate to the severity of the symptoms. Tenderness is constant in occurrence, but somewhat variable in location. Rigidity is seldom marked. A palpable mass is usually found only in late cases and indicates abscess or cyst.

The laboratory offers scant aid in diagnosis. Glycosuria is uncommon, contrary to the logical expectation. There is almost always a leucocytosis and it is often very high. The British lay particular emphasis upon testing for diastase in the urine. We have had no experience with this. The adrenalin midriatic test of Loewe has given us no aid in diagnosis.

## TABULATION OF CASES

Bloody exudate	Gall bladder disease	Condition of pancreas	Operation	Complications	Result	Comments
+	?	Necrosis	Parapanc drain cystostomy	Fever 3 wk	Well 2 yr	Deferred surgery
?	Stones	Hæmorrhage	None		Death 6 hr	Moribund on admission
+	Stones	Edema	Parapanc drain cystostomy		Death 5 hr	Operation probably hastened death
+	Not seen	Hæmorrhage	Drain of panc		Death 21 hr	Too sick for operation
+	Stones	Gangrene	Drain of panc		Death 3 da	Too sick for operation
o	Stone	Edema	Cholecystostomy		Well 3½ yr	Deferred surgery
+	Not seen	Hæmorrhage	Parapanc drain	Pneumonia ventral hernia	Well 1½ yr	Operation probably beneficial
+	Stones	Necrosis	Drain of panc cystostomy	Pleural effusion—pancreatic abscess	Well 2 yr	Deferred surgery
+	Stones	Edema	Drain of panc cystostomy		Well 2 yr	Operation probably beneficial
+	Stones	Hæmorrhage	Drain of panc		Death 5 da	Operation justified by suspicion of ruptured viscus
+	Present	Edema	Drain of panc cystostomy	Secondary hæmorrhage	Death 3 da	Death from postoperative hæmorrhage
+	Gangrene	Hæmorrhage	Drain of panc cystostomy		Death on table	Operation justified by gangrene of gall bladder
+	Present	Hæmorrhage	Drain of panc cystostomy	Pleural effusion	Well 6 mo	Deferred surgery
o	Stones	Edema	Drain of panc cystostomy	Toxic delirium	Well 6 mo	Deferred surgery

## TREATMENT

It is virtually unanimously conceded in this country that an immediate laparotomy is the proper procedure. Most European surgeons are in agreement. In Denmark, however, dissenting voices arise. Mikkelsen has recently quoted Rovsing, Holst, and other Danes as in favor of expectant treatment. They believe that operation is best deferred until the pancreatic symptoms subside unless diffuse peritonitis or abscess formation supervenes. Mikkelsen reports the recovery of 50 consecutive cases treated either non-surgically or with deferred operation as compared with a 66 per cent mortality following immediate operation. Among those who favor immediate intervention there is considerable variance as to the type of procedure. Some favor a simple laparotomy with drainage of the greater peritoneal cavity. Others make a direct attack upon the pancreas. Still others confine their attention to the gall bladder and its ducts without any attempt to drain the pancreas itself. Sometimes a combination of methods is utilized. Our custom has been to open the

necrotic pockets in the pancreas, by means of either a blunt hæmostatic forceps or a cautery. Soft cigarette drains are then introduced in coffer dam fashion. The tensely distended pancreas is thus decompressed and, at the same time, an exit is provided for the necrotic material. The question of coincident surgery upon the biliary tract has to be answered for the individual case. Although cholecystectomy may, in theory, be the procedure of choice, nevertheless, it is certainly unjustifiable in critically ill patients. Under such circumstances surgical drainage of the biliary tract must suffice until a later date.

Our predilection for immediate operation in acute pancreatitis has been in full accord with the common practice among surgeons. Nevertheless, an analysis of results in our own series of cases herewith reported awakens grave doubts as to the rationality of our position. There appears to be much which substantiates the Danish viewpoint upon deferred operation as previously described. Out of 8 cases operated upon immediately (within 48 hours of onset of attack) 6 died. On the other

hand, in another group of 5 cases in which, for one reason or another, operation was deferred to a later period—from the fourth to the ninth day of the disease—all of the patients recovered. In the first group due credit must be given to the operative procedure in the 2 cases which survived, in 2 other patients justifiable indication existed for performing an emergency laparotomy (One had gangrene of the gall bladder. In the other an X ray report of gas under the diaphragm led to a mistaken diagnosis of perforated ulcer. The X ray appearance was later shown to be due to an anomalous position of the right lobe of the liver and the transverse colon.) In the 4 remaining cases, operation (far from conferring any benefit upon the patient) appeared to hasten the exitus. Three were too ill to survive the shock of operation and 1 succumbed to secondary hemorrhage.

Immediate operation therefore gave a mortality rate of 80 per cent with no obvious benefits save in the 2 cases which recovered. Deferred operation was followed by recovery in each instance. Our series is completed by a single patient who died without operation within a few hours of his admission. In this small group of cases the results were strikingly significant.

We wish to add to the list a case which was neither operated upon nor was autopsy examination made. The diagnosis therefore, rests entirely upon clinical data. Being open to criticism on this score, it has been omitted from the tabulation of the verified cases. The evidence however convinced us that this patient recovered from a severe attack of acute pancreatitis.

M. A. female aged 57 years admitted to the hospital September 23, 1927. She had had no gastrointestinal symptoms until 6 weeks previously. Coincidentally there developed knife-like epigastric pain and vomiting. The pain was intermittent, steadily increasing in severity aggravated by food, and did not radiate. The vomiting was persistent and bilious. Bowels were regular. There had been evidence of progressive cardiac incompetency for several months. Patient was extremely obese, she was orthopneic and cyanotic. Her blood pressure was 155-70. Temperature, pulse, and respiration were normal on admission. Entire upper abdomen was tender, no rigidity or masses. Urine was negative, white blood cell count 22,200, blood urea

nitrogen 23 milligrams, blood Wassermann negative, blood sugar 0.117 per cent. X ray examination by Graham Cole method showed pathological gall bladder.

In view of the patient's critical condition, the cardiac embarrassment, and the dehydration on admission, operation was deferred. Fluids and glucose were given by bowel under the skin, and by vein. There was no vomiting after admission, but severe pain persisted. On the following day pain was less severe, but the temperature rose to 102 degrees, pulse was 110 and leucocytes 24,600. There were periods of delirium. On the fourth day a striking improvement was evident. The temperature reached normal almost by crisis. The symptoms subsided. Leucocytes were 5,600. The patient was in good health 8 months after discharge and there had been no recurrence.

### COMPLICATIONS

Few surgical procedures are associated with as varied an assortment of inherent complications as operations for acute pancreatitis. Secondary hemorrhage is common and is a manifestation of the natural hemorrhagic tendencies of the advanced stages of the lesion. Korte recorded an incidence of 21 per cent. In one of our patients whose pancreas at operation showed only edema, intractable bleeding from the wound margins and from the pancreatic region began the day after operation and continued until death. The process is one of progressive erosion of blood vessel walls by tryptic digestion. No treatment appears to avail.

The syndrome described by Whipple and designated "pancreatic asthenia" occurs frequently. It is characterized by asthenia, progressive fall in blood pressure, anorexia, or capricious appetite, nausea, and loss of weight. (The same complication is often observed with associated chronic pancreatitis.) The feeding of pancreatic extract may be of value.

Defective wound healing due to the discharge of pancreatic secretions accounts directly for two common sequelae, namely, persistent sinus and ventral hernia. For the protection of the wound margins from tryptic digestion, we have used a paste composed of beef extract and zinc oxide ointment with satisfactory results.

The detection of any epigastric mass should arouse the suspicion of a residual abscess or,

if later in convalescence and not associated with fever of pancreatic cyst. One of our cases developed an abscess in the tail of the pancreas. This was successfully drained by lumbar incision.

Recurrences are reported even after the most radical operations. Bailey records a case with fat necrosis, an oedematous purplish pancreas, and a non-calculous cholecystitis. Cholecystectomy was done. One year later the patient returned in *extremis*. The autopsy disclosed a typical hæmorrhagic type of pancreatitis. We also had a case developing 2 years after cholecystectomy (Case 9 in table). Love observed 28 cases over a period of one year and found that 16 of them had biliary colic similar to that experienced before operation. This return of colic may have been due to stones which were overlooked. In a case of Waring and Griffiths, the shortening of drains on the fifth and again on the tenth day was followed by abdominal pain and vomiting. One of our patients (Case 10) improved after operation, but died following a recrudescence of symptoms on the fourth day. Autopsy showed an extension of the necrosis beyond the limits found at operation.

Diabetes might be anticipated as a sequela of a disease so destructive of pancreatic tissue. Strangely enough, it is rare. This may be due to the fact that the islands of Langerhans are found more abundantly in the tail of the pancreas whereas acute pancreatitis, in most instances, occurs in the head of the gland.

#### SUMMARY AND CONCLUSIONS

1 Acute pancreatitis is not an extremely rare and is entitled to more serious consideration than is customarily accorded it.

2 The etiology is not understood although much experimental data has accumulated. Cholecystitis is certainly a prominent factor.

3 The correct diagnosis was made before operation in not more than one-third of the cases reported in the literature. The character of the pain and the appearance of cyanosis are the most distinctive of the diagnostic criteria.

4 The mortality of all the collected cases is 51 per cent. Our own figure (50 per cent) conforms with this.

5 The accepted mode of treatment by emergency laparotomy may not be the best one. Our experience favors dealing with these cases as one would with an uncomplicated acute cholecystitis or an acute salpingitis, namely, deferring the operation until after the acute phase, unless an occasion arises demanding immediate surgical interference.

6 A train of distinctive complications, for the most part incident to operative interference, increases the hazard of early operation.

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Unless something superior in every way to "twilight sleep" could be evolved, the method would be useless. "Twilight sleep" seemed to depend upon amnesia, while suffering during labor was real. The fundamental factor in the present method is *analgesia*, although amnesia is present with the colonic method probably quite as often as in twilight sleep. (No record of amnesia has been kept.) Harrar (10) says "The casual observer would have the impression that there was very little amelioration of the pain, the patient complaining and restless during the contractions, and yet afterward we find the amnesia secured to have been as definite as that after *scopolamine*. Frequently the patient confesses of her own volition that she remembered very little after the rectal instillation was given."

The standard method consists of three intramuscular injections of magnesium sulphate and one retention enema, but in prolonged labor this complete technique, in many cases, has been repeated twice, and occasionally three times, without detriment to either mother or child. In a personal communication, Dr. Henry T. Burns, former house surgeon of the New York Nursery and Childs Hospital, New York, gives a case history of one patient, in labor 57 hours, in which the synergists were used, which finally came to an extraperitoneal caesarean section. The premature baby was born crying.

#### REPORTS OF PROGRESS

In accordance with the fourth condition listed above, my first report (6) was published in October, 1923. At that time the term "painless childbirth" was used to designate the method, but this designation merely represented an ideal. In that paper I stated "The results have varied, but in the majority of the cases the patients have been helped,—the pains were lessened, and in a few a comparatively painless delivery has occurred. Others were not helped in the slightest, while one or two stated that the pains were intensified." The same term was applied to the method in my second paper (7). The term "obstetrical analgesia" was used for the first time as the title of a paper (4) read by me before the New York Obstetrical Society,

December 9, 1924. Since that time this term has been accepted generally as defining the state or condition of the patient, and is now in common use.

In 1925, after practically 2 years' experience with the method, Doctor Davis (1) assigned 16 reasons for using the method:

1. Ninety per cent of the patients secure some relief many a great deal. Poor results are often due to faulty administration and faulty modifications.

2. It can be used as easily in a home as in a hospital. In the Out Patient Department of the Lying In it has been given to over 300 patients by the house staff.

3. It is inexpensive especially when compared to gas oxygen analgesia when given over a prolonged period during labor.

4. It requires no especially trained person to give the actual injection or the actual instillation, any trained nurse can give them. No special attention is required.

5. The physician does not have to be present at all times throughout labor.

6. The drugs recommended by Gwathmey have all been safely tried out in other fields of medicine previous to their use at the Lying In Hospital.

7. The use of the drugs prescribed by Gwathmey for over 2 years at the Lying In Hospital in over 1,500 labors has proved that they are safe in obstetrics. If a cardiac case or a toxemia case or a case of placenta previa is permitted to go into labor, the use of the analgesia is not contra indicated. No presentation or position is a contra indication to its use.

8. Contra indications: Colitis, true diabetes and auditory disturbances are the only contra indications.

9. The patients are quieter during labor, undergo less strain and therefore are in better general condition the day after labor is completed.

10. The ether instillation relaxes the perineum so that, if anything, the perineal stage is more rapid.

11. The intramuscular injections cause no subsequent painful induration of the muscle as do mercury injections. Abscesses occur no more frequently than with other hypodermic injections. In over 6,000 injections only 6 abscesses developed and in at least 4 instances these could be traced to faulty technique.

12. By comparative statistics at the Lying In Hospital operative deliveries, asphyxia of the fetus during labor, stillbirths and postpartum hemorrhages even if the delivery occurs within 1 hour after morphine-magnesium sulphate injections are not more frequent than if the method had not been used.

13. When the occiput is in the posterior position labors are usually longer than when the occiput is in the anterior position. The analgesia, however, does not prolong the labor still more in such cases.

14. There is no subsequent rectal irritation, only occasionally a slight burning sensation during the instillation.

15. Vomiting during labor is only a little more frequent than that observed in labors without the analgesia.

16. If it excites the patient she does not have to be forcibly held in bed, as was so frequently the case with twilight sleep.

17. Labors are rarely prolonged.

As the work progressed, charts and instructions were introduced into other hospitals in this city, and later into those of other cities.

and as the results in all of these hospitals compare favorably with those obtained at the Lying-In Hospital, it is believed that we have accomplished, in large measure, what we started out to do, namely, relieve pain, with no increase in stillbirths, and with no interference in any way with the normal processes of labor. The following figures, compiled in December, 1928, amply substantiate this belief.

STATISTICS<sup>1</sup>

Cases

Lying In Hospital, New York.

The "Analgesic Record" (Fig. 1) charts for 2 years show that the method is used on an average of 240 times each month (approximately 68 per cent of all cases),<sup>2</sup> or 2,880 times per year, and that for the five years since the method was introduced it has been used in

14,000

(This does not include the private cases, which are not charted.)

New York Nursery and Childs Hospital, New York.

Between 500 and 600 obstetrical analgesias per year are given, a total for 5 years of over

2,500

Manhattan Maternity Hospital, New York.

Four hundred cases a year, or, for five years

2,000

Cincinnati General Hospital, Cincinnati, Ohio,

and private cases of Doctors Crudington, Beatty, and others

2,000

## RESULTS

The medication varies in its results from a slight sedative effect to analgesia with unconsciousness, and amnesia. The *progress of labor is not delayed*. Occipitoposterior positions rotate in about the same proportion as in normal labor. Postpartum hemorrhage is less than with any inhalation method. If anything, the use of forceps is decreased, and the baby, as a rule, is born crying. A former house surgeon of the Out-Patient Department of the Lying-In-Hospital, in a personal communication, stated that the incidence of forceps delivery had been reduced over 50 per cent since the method had been used.

When all of the factors just mentioned are present, i.e., analgesia, amnesia, no delay, baby crying, the result is listed on the chart as "A". If the effect is not sufficiently prolonged or is less complete, it is marked "B". Where the patient is merely helped, or where there is only slight sedation, it is marked "C". Where no relief is obtained, the chart is marked "D".

<sup>1</sup> Information given by superintendents of hospitals named and by Doctor Crudington for Cincinnati.

<sup>2</sup> Sollmann (*Manual of Pharmacology*) says Scopolamin morphine is applicable in only 30 per cent of all cases.

Morbidity of the mother is decreased, and no fetal deaths attributable to the analgesia have occurred. Certain cases do well with the intramuscular injections of magnesium sulphate alone, or with the rectal instillation alone, but the best results are obtained when the full technique is used. When the patients come in with the cervix four fingers dilated, they are relieved considerably of pain with the intramuscular injections of magnesium sulphate, with or without morphine.

There need be no fear in using the technique in cases of contracted pelvis or disproportion between baby and pelvis where a trial labor is indicated, for many will deliver normally. If they do not deliver, they have a great deal more reserve strength with which to withstand a hard forceps delivery or cesarean section. Concerning cesarean section Harrar (11) says "When one has occasion to perform a cesarean section under local anesthesia, an ideal preliminary procedure is to reverse the sequence, giving the rectal ether instillation an hour before the operation and the hypodermic dose of morphine 20 minutes before. This will place the patient in perfect condition to receive the local novocain injections and the analgesia is greatly augmented. Recently we have followed this technique in several cesarean sections under local anesthesia, and the absence of suffering on the part of the patient has been noteworthy." In a personal communication Dr. R. J. Lowrie states "Where labor may seem to be prolonged, there is compensatory increase in the comfort of the patient."

Patients who go through labor with the synergists have less postpartum fatigue and consequently less morbidity. They feel better and insist on getting out of bed early. The Lying-In Hospital has constant supervision over most of their cases for many months before and after delivery, and no contra-indication to the method has been noted in regard to after-effects. The method, therefore, has been analyzed from every possible angle. The small amount of instillation, 4 ounces, is easily retained. Careful timing of the different factors secures better control of the distress and pains of labor than is possible by any other known method.

## ANALGESIC RECORD

LYING IN HOSPITAL, MARCH 1927-28-29

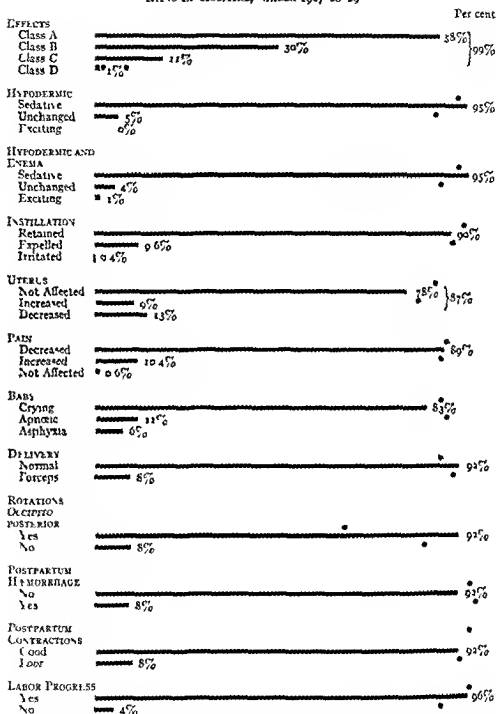


Chart showing standardization of method arranged from the analgesic records for three consecutive years for the month of March, each record made by a different house surgeon. The black line represents March 1928, the dot above the line March 1927, the dot below the line, March 1929. The figures after the lines are percentages.

The house surgeons of the Lying-In Hospital are changed every 4 months, as are also their associates and assistants. Since starting this method it has been in the hands of over 200 inexperienced men, none of whom knew anything of either colonic anesthesia or obstetrical analgesia before coming to the hospital. The method has been employed over 3,000 times in the Out-Patient Department of the hospital, in the homes of the patients, where it is given under the most trying conditions imaginable, but even under these circumstances it is successful in over 80 per cent of the cases, and no fatalities attributable to the method have occurred. We are justified in stating that it is simpler than any other method, and can be used anywhere. In not a single instance has an anesthetist been used with the method, even in its initial development. The ingredients are cheap, and the mixture can be prepared easily by any pharmacist, or by physicians who are accustomed to prepare their own medicines.

In the *Annual Report* of the Lying-In Hospital for 1925, Davis stated that he had yet to learn or to observe that any mother or child had been endangered by it. In the *Annual Report* for 1928 he says: "Not long since, 8 patients were seen in two rooms in the hospital in different stages of progressing labor. No outcry was heard. They were being treated with analgesia, and at least relieved of much of their pain. We know of no other safe method of treating such patients which will produce like results."

It is unusual for the attending staff of a hospital to be as unanimous on any medical subject as are the chief and the attending surgeons of the Lying-In Hospital concerning this technique for the relief of pain. Practically every private patient entering the hospital receives the treatment

employed by the inexperienced during the period of its development, there is no good reason why it should not continue to be used by them as well as by the expert obstetrician.

2 If mistakes are made, no harm can result to either mother or child.

3 Increased success will come with experience. Those who take the trouble to explain to the patient, and thus secure her co-operation, will obtain better results than those who administer drugs in a mechanical manner.

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# CONCLUSIONS

1 Inasmuch as "Obstetrical Analgesia" never reaches full surgical anesthesia, and was

## HÆMORRHAGE AND "SHOCK" IN TRAUMATIC LIMBS AN EXPERIMENTAL STUDY<sup>1</sup>

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THE causes of circulatory failure in surgery are numerous and two or more factors often coexist. Extensive wounds and operative procedures are often complicated by it. In the case of injuries, four of the most commonly considered conditions which might bring it about are hemorrhage, contused tissues with resultant traumatic toxæmia, injured nerves, and fat embolism. Anæsthesia may also have to be superimposed in connection with treatment. In the case of operations, the most important additional factors are the disease for which the operation is performed and the anæsthetic. There has been a great deal of speculations as to the relative importance of hemorrhage, contused tissue, injured nerves, and fat embolism in the causation of circulatory failure. It has always been known that hemorrhage alone will produce circulatory failure, but for more than a century it has been held that a severe injury or operation might bring about a similar picture somehow through its influence upon the nervous system. The term "shock" was first applied to this condition by James Latta in 1795. Since the introduction of this theory there has been a great deal of controversy as to how the changes might be brought about. Most of the earlier explanations offered were very vague. Sir Astley Cooper, Copland, Morris, and Jordan regarded shock as due to general depression of the nervous system through gross mechanical insult. After Claude Bernard's discovery in 1852 of the sympathetic control of the blood vessels, Weir Mitchell, Moorehouse, and Keen in 1865 were the first to regard shock as a reflex vasomotor paralysis. Fischer, in 1870, reasoned from the tapping experiments performed on frogs by Goltz that injury caused a reflex paralysis of the vasomotor nerves with a fall in blood pressure and dilatation of the great veins of the visceral regions. The theory was offered as an explanation of the circulatory failure occurring

in connection with injuries both of the abdomen and of other parts of the body. Against the theory of vasomotor paralysis was the discovery of Loven in 1866 that stimulation of the central end of a cerebrospinal nerve caused elevation instead of lowering of the blood pressure.

Cruikshank advocated the view that circulatory failure might result from exhaustion of both the vasomotor centers and brain cells as a result of an excess of sensory impulses from the injured field. Lockhart Mummery also supported the theory of vasomotor failure. However, numerous investigators as Porter, Mann, and Lwing and Janeway, have shown that very prolonged stimulation of somatic nerves in mammals does not bring on circulatory failure.

Meltzer presented experimental evidence in favor of the theory of reflex inhibition as the cause of lowered blood pressure in abdominal operations. He noted that intestinal movements in rabbits seen through the abdominal wall ceased when the overlying skin was incised and remained paralyzed when the abdomen was opened. Howell thought that surgical shock might be due to reflex stimulation of the cardio-inhibitory center.

Little of the recent work has tended to further the cause of the nervous theory as an explanation of circulatory failure in severe injuries. Also we were unable to find reports of autopsies on persons dying of severe injuries, such as the renowned solar plexus blow, in which sufficient pathological changes as hemorrhage, injury to a vital organ, as brain or spinal cord, or fat embolism were not found to account largely for death. However, it should be remembered that the term "shock," whether used in a popular or a medical sense gives rise to the thought of a severe nervous or mental disturbance produced by psychic trauma, as bad news, in the one case, or by bodily injury in the other.

<sup>1</sup>A part of this work was done on a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago. Submitted for publication February 22, 1930.

## THE THEORY OF TRAUMATIC TOXÆMIA

The first evidence that a chemical substance would produce a shock-like state was offered by Heidenhain, in 1891, who found that peptone when injected intravenously in certain animals, produced marked exhaustion, rapid pulse and respiration, and low blood pressure. Dale and Laidlow in 1910 found that histamine when injected intravenously produced a similar but more marked shock-like effect through its vasodilator action on the capillaries and arterioles.

During the Great War, the view became current in the Allied countries that an important factor in the production of circulatory failure in the severely wounded was the formation of a toxic vasodilator substance in the damaged tissues which on passage into the blood stream brought on the picture of circulatory failure which was commonly spoken of as "wound shock." Other factors of varying importance were hæmorrhage, exposure to cold, exhaustion and fright. Delbet thought that the toxic substance might be the product of tissue autolysis. This theory of traumatic toxæmia was supported from the clinical side by Delbet, Quénu, and Fraser and Cowell, and from the experimental side especially by Bayliss, Cannon, and Carmoisy and Kotzareff. Soon after the war a great deal of experimental work was published, most of which tended to support the theory of traumatic toxæmia. The results of the clinical and experimental observations growing out of the war are summarized in the valuable treatise by Cannon on *Traumatic Shock*, published in 1923.

## CHEMICAL CONTROL OF THE CIRCULATION

Aside from vasomotor nerve control of the blood vessels, there is chemical control exercised by normal constituents of the blood, and of the tissues themselves, or by metabolites formed as a result of altered physiological conditions, either local or general. In the blood there are the hormones, as adrenal and pituitary secretions, acids, bases, and salts, disturbance of the contents of which may alter the state of the circulation. Thus increasing carbon dioxide in a part according to Hooker and Anrep, by increasing the carbon dioxide

tension causes peripherally a relaxation of the blood vessels. A discussion of these factors would lead too far afield, as many of them change only secondarily, but the recital of a clinical case throws some light on the possible role of the adrenal gland in the maintenance of vascular tone. A male, aged 38 years, with a blood pressure of 128-82, had tuberculosis of the right kidney. A nephrectomy was performed by Dr G M Curtis, with little loss of blood. Within 2 hours, his temperature went up and his blood pressure started down, and 18 hours later it was 60 millimeters mercury. He was cyanotic but otherwise appeared fairly well. The pressure remained about that level for 12 hours, the temperature stayed around 104 degrees, and he stopped secreting urine. He was then given three doses of 1 cubic centimeter of 1:1000 adrenalin at hourly intervals which produced only temporary elevation of pressure, after which it declined still further and he died 40 hours after operation with the picture of peripheral circulatory failure. Autopsy showed nothing of consequence except almost complete destruction of both adrenal glands by tuberculosis. Cases like this make one feel that in man the adrenals may have something to do with the maintenance of vascular tone despite the evidence to the contrary which may be deducted from animal experimentation. It looks as if this man who was on the verge of adrenal insufficiency from Addison's disease was carried over the threshold by the strain of the operation.

Injury of shed blood by traumatism or by laking from freezing and thawing greatly alters its vascular properties. Handy and Pphemister found that re-injection or circulation by means of a vivi perfusion apparatus of several cubic centimeters of slightly traumatized or slightly hæmolyzed blood in the femoral artery caused vasodilation in the limb of a dog, but that these same amounts of severely traumatized or completely hæmolyzed blood caused vasoconstriction when circulated in the limb. We have tested this further by the injection of completely hæmolyzed or severely traumatized blood in small quantities (1 to 50 cubic centimeters) into the left heart or first portion of the aorta, so that it reaches the

general capillary bed in high dilution. It produces a sharp decline in blood pressure which with 25 to 50 cubic centimeters may be as much as 70 millimeters of mercury. But the recovery was always very prompt (one half to 2 minutes) and when it was injected more gradually the blood pressure would return to the previous level before the injection was completed (Fig. 1). Injections into the right heart produce very much less fall in general arterial blood pressure than those into the left. It seems that passage of the damaged blood through the lung capillaries robs it very largely of its vasodilator property, and passage through the capillaries of a limb completely destroys it. The immediate incompatibility reactions in the blood transfusion may have some relation to this phenomenon, and it was considered as a possible causative factor in low blood pressure from severe injuries where damaged blood is extravasated in the tissue, although if toxins of damaged blood in the tissues entered the circulation, they would probably be detoxicated in the lung capillaries before reaching the general capillary bed.

The cause of the vasodilation is unknown. It was thought that it might be due to a histamine like substance liberated from the broken down cells, but this is not so, since, when the amount of histamine injected into an animal is increased the fall in blood pressure becomes more marked and prolonged, whereas very large amounts of extensively hemolyzed or severely traumatized blood (200 to 400 cubic centimeters) circulated through a peripheral artery do not lower general blood pressure at all and when circulated through a vein produce only an initial fall for 1 to 2 minutes. This paradoxical behavior when varying concentrations and amounts of damaged bloods are injected may be due in part or whole to physical chemical changes, not to a toxin acting on the cells.

That the various tissues of the body normally contain substances with vascular properties is well known. Alcoholic extracts of most tissues contain a vasodilator substance, while according to Collip, acetone extracts contain a vasoconstrictor or pressor substance.

Interference with normal physiological processes in a part of the body may result in the

local occurrence of vasodilation, which is independent of nerve supply, since it occurs in limbs that have been denervated, as well as in limbs with intact nerves. An example of this is the vasodilation which occurs in a limb during a period of constriction which completely or even partially interrupts the circulation. On release of the constrictor, reactive hyperemia develops, the limb increases in volume beyond normal and flushes from the rush of blood. This gradually wears off in one half to three fourths the duration of the period of constriction. The cause of the vasodilation is unknown, but according to the theory of Anrep it may be due to a metabolite found in the tissues during the period of constriction. If this is so, perhaps some of this metabolite is washed out by the venous blood during the period of the hyperemia. Handy and Phemister tried to demonstrate the presence of a vasodilator substance in the blood collected from the femoral vein during the period of reactive hyperemia following obstruction of the femoral artery. It was recirculated in the recovered limb from a viviparous perfusion flask connected with the femoral artery. If the blood was not traumatized it produced no vasodilation when circulated through the limb, consequently by this method we could not demonstrate the presence of such a substance.

Such a vasodilator substance passing from the limb into the general circulation might cause a fall in general blood pressure. We have observed the blood pressure and pulse rate after release of a constrictor to the thigh of a normal man and have found them to change but little if at all. A blood pressure cuff was applied and the blood pressure raised to 225 millimeters of mercury. When the limb was previously rendered bloodless by the application of a spiral bandage and the constrictor left on for 15 minutes removal was followed by a very slight fall of systolic pressure, in two experiments from 106 to 102 millimeters within 3 minutes and the pulse rate was changed from 72 to 76. Blood pressure and pulse gradually returned to normal in 8 to 10 minutes. This might easily be accounted for by the return to the limb of its normal quota of blood plus the additional blood drawn in by the reactive

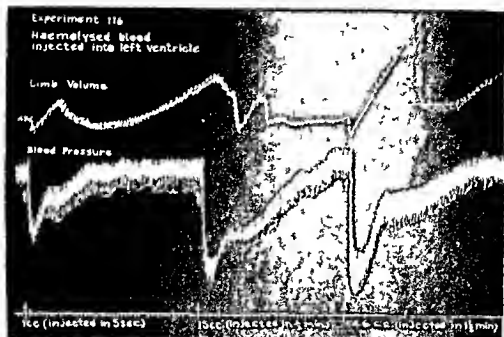


Fig 1 Fall in blood pressure and changes in limb volume from injections into left ventricle of haemolysed blood. The decline from the initial blood pressure of 112 was 54 millimeters produced by 1 cubic centimeter, 62 millimeters by 15 cubic centimeters and 75 millimeters by 46 cubic centimeters. Note the rise toward normal even during the injection of 46 cubic centimeters.

hyperæmia. When the circulation was interrupted repeatedly by rapidly elevating the pressure to 225 millimeters without first emptying the limb of blood, and released in 15 minutes, the blood pressure and pulse rate remained practically unaltered.

In a large number of experiments on animals in which the femoral artery or occasionally the terminal aorta was obstructed for varying lengths of time up to one hour, we have never observed a fall in blood pressure suggesting the entrance of a vasodilator substance into the general circulation. Consequently we do not feel that there is sufficient evidence to warrant the conclusion that after release of vascular obstruction of a part, vasodilator substances producing a fall in blood pressure make their way into the general circulation.

In an extensive study of the responses of the blood vessels of the skin, Sir Thomas Lewis has offered much experimental evidence to support the theory that mechanical, thermal, electrical, photo, and chemical stimulations of the skin liberate a histamine-like substance which causes local redness, oedema, and in extreme cases hæm formation. He believes that the vasodilator substance is liberated principally by the irritated vascularized por-

tion of the epithelium. He thought that in case of extensive irritation of the skin, this vasodilator substance might pass into the blood stream and bring about general circulatory changes. Thus, persons with sensitive skins in whom urticaria factitia could readily be produced were treated by extensive stroking and combing. This resulted in flushing of the face, general rise of skin temperature, and a small temporary fall in blood pressure. He believes that the deeper tissues would respond in this same way to traumatism and that his experiments indicate that the circulatory failure in extensive injuries as well as in anaphylaxis and related phenomena result from the liberation of a histamine-like substance which passes into the circulation and acts on the general capillary bed.

It is an interesting fact that while in the Allied countries "shock" was a subject of great concern, it received very little attention in Germany and Austria. They did not use the term "shock" to designate serious states in the wounded produced by hæmorrhage, infection, exposure, etc. According to Wieting, who wrote an elaborate review of the subject in 1921, the few who believed in it held vaguely to the theory of vasomotor paralysis.



He considers that while such a condition occurs, it is very rare in comparison to fall of blood pressure produced by other factors.

Fat embolism of the vasomotor centers in the medulla as a cause of early shock in war wounds was advocated by Porter both on clinical and experimental grounds. His clinical evidence was very superficial and indirect, consisting largely in the observation that "shock" was much more frequent when a fracture formed a part of the wound, which would pre-dispose to fat embolism. On the whole the pendulum has swung far to the side of traumatic torremia as an explanation of circulatory failure occurring in wounds and operations regardless of the part of the body that is affected. Thus circulatory failure due to wounds of the extremities and to abdominal operations and injuries has been supposed by some to result from the same cause, although nearly all of the evidence offered in support of traumatic torremia is based upon experiments performed on the extremities.

Now that some time has elapsed since these clinical and experimental observations growing out of the war were made, a reconsideration of the subject of circulatory failure seems indicated. Doubt was cast on many of the older theories by the work of Mann in which he found that it was impossible to cause shock by traumatization alone without opening the abdomen without inducing hemorrhage, or without injury to the medullary centers. Blacklock has recently criticized the loose present day usage made of the term "shock." He considers shock not as a disease but as a group of symptoms which may be produced by a number of conditions including acute hemorrhage, wounds, and anesthesia. He has studied experimentally the effects of hemorrhage and of trauma to the central nervous system on cardiac output, blood pressure, oxygen consumption, and pulse and respiration rates. He found the order of change in a progressive hemorrhage to be diminution in cardiac output, acceleration of pulse rate, fall in blood pressure, rapid and sighing respirations, stupor and exhaustion, and called the condition "shock due to hemorrhage." He believes that the fall in blood pressure in injuries of the central nervous system is due both to

hemorrhage and to nervous injury with reflex vasomotor paralysis. He did not suggest that a toxic substance might be liberated from the damaged brain which produced vasodilation upon entering the circulation. He found the venous blood from the traumatized or exposed part, which had resulted in lowered blood pressure, to be higher in oxygen content than in normal controls.

#### EXPERIMENTAL WORK

The theories of circulatory failure as applied to wounds of the extremities have been tested in a series of 70 experiments on anesthetized dogs, a preliminary report of which has been published by one of us (C. P.). The anesthetic employed was morphine and ether in 24 cases, ether alone in 17 cases, morphine and barbital in 18 cases, and barbital alone in 11 cases. When morphine (0.03 grams morphine acetate per kilo body weight) was used the blood pressure at the beginning of the experiment was usually 10 to 40 millimeters lower than when ether or barbital alone was used. Otherwise the results under the different types of anesthesia were very similar. We studied the effects of stimulation of the nerves of the limb, of traumatism of the limb, and of bleeding. Blood pressure tracings were made from a cannula in the carotid artery. When trauma was produced the left hind leg was hammered with a two pound padded hammer vigorously enough to bruise and lacerate the soft parts without breaking the skin or bones, except in occasional instances.

#### NERVOUS THEORY

The theory that wounds of the extremities produce circulatory failure through their effects on the nervous system was tested in 8 experiments by the experiment of exposure and stimulation of the sciatic nerve or the sciatic and anterior crural nerves, by frequently repeated crushings with forceps and by the application of a faradic current. At the beginning of stimulation there was a rise in blood pressure (Loven reflex) which was usually sustained as long as the stimulus was actively applied. In some of the experiments where the faradic current was applied it was kept up for more than an hour. In no instance

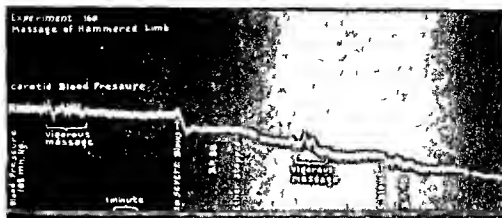


Fig. 2 Limb hammered 45 minutes previously when blood pressure was 120, shows no fall in pressure from massage but a fall from traumatism

was there a resultant fall in blood pressure. This confirms the observations of most investigators, as Porter, Mann, Janeway, and Ewing.

An attempt was made to determine the rôle of the nervous system in animals where circulatory failure was produced by traumatizing the limb. In 10 experiments the limb was denervated just before traumatizing, and in the others the nerves were intact. When the nerves of the limb were intact, hammering eventually resulted in a fall in blood pressure which was directly dependent on the amount of injury and was as great as in an animal the hammered limb of which had been denervated. It has been claimed that in circulatory failure from injury to the extremities, there are dilatation of blood vessels and stagnation of the blood in the splanchnic areas due to vasomotor paralysis, thereby resulting in a decrease in the amount of circulating blood. We necropsied dogs which died as a result of traumatism of the extremities and found no dilatation or engorgement of the blood vessels of the intestines and other abdominal viscera. On the contrary the intestines were pale. There was no evidence in these experiments that stimulation of the somatic nerves of an extremity causes fall of blood pressure.

#### TRAUMATIC TOXÆMIA

The theory of traumatic toxæmia was tested in 45 animals with low blood pressure produced by hammering the lower extremity. As a rule in dogs weighing 10 to 15 kilograms, it was necessary to deliver about fifty blows in

succession with a padded hammer in order to bring about a fall in blood pressure. The immediate fall was usually not great and sometimes the pressure returned to normal within a few minutes. Two or three hammerings of the same severity are usually necessary in order to bring the pressure permanently to 75 millimeters of mercury or lower. The length of time that the animals lived after this trauma varied greatly from a few minutes to several hours depending on the severity of the injury. When ether was being administered it was usually withdrawn in case the pressure reached a level below 75 millimeters and the animals did not regain consciousness. With the fall in blood pressure the pulse regularly increased correspondingly in rate and the respirations became accelerated and shallow.

If the circulatory failure in this condition is caused by toxic substances formed in the damaged tissues, then massage of the traumatized limb might force out an extra amount of the toxin which would produce a further fall in pressure. However, as a rule it was found that massage or extensive manipulation of the limb produced no fall in pressure (Fig. 2). Sometimes there was a rise in pressure in innervated limbs produced no doubt by the Loven reflex. Rarely there was a fall and this was usually when the pressure was moderately lowered. These findings are in marked contrast to those of Cannon obtained on cats, in which he reported a fall in blood pressure as a result of massage and manipulation of traumatized and fractured limbs which had increased only slightly in volume from the injury, in

some instances as low as 10 per cent. The exceptional fall in blood pressure in our experiments was interpreted as probably due to further hemorrhage set up by the manipulation, since the animals had passed the critical point where a slight loss of blood would cause a sharp decline in pressure. However, there remained the possibility of a traumatic toxin.

The concentration of the blood was determined in these experiments in a search for evidences of traumatic toxin. Dale and Richards found that in histamine poisoning there is an increase in the concentration of red cells in the peripheral blood and Underhill has noted the same thing in severe burns. Erythrocyte counts and hemoglobin estimations were made on the capillary blood of the ear of these dogs and a decrease in the number of cells and reduction in hemoglobin were regularly found. In no instance was there evidence of a concentration of the capillary blood. The results of arterial and venous counts in one experiment are shown in Table II.

In view of the observation that dilute hemolyzed or traumatized blood entering the circulation may cause a fall in blood pressure it was thought that damaged, extravasated, and hemolyzed blood in the traumatized limb might enter the circulation and bring about a fall in pressure. In this event the plasma would be stained with hemoglobin. Blood was withdrawn from the jugular vein in seven of these experiments and centrifuged and the plasma was examined for the presence of hemoglobin. In no instance was it found except in very minute traces. A liberated toxin might be absorbed into the circulation and lower blood pressure without the entrance of hemoglobin. To test this point blood was collected from the femoral vein of the traumatized limb in a *vivi* perfusion flask without shaking as used by Phemister and Handy. It was promptly circulated through an untraumatized limb of another dog after the flask was connected with a cannular system in the femoral artery. It did not produce vasodilation in the limb, and in no case did it cause a fall in general blood pressure.

It is known that alcoholic extracts prepared from various tissues produce a fall in blood

pressure when injected intravenously. The depressor effect of alcoholic extracts of muscle traumatized *in vivo* was found to be the same as that of normal muscle removed after death of the dog. The extravasated blood collected from five traumatized limbs was also extracted with alcohol. The extract produced a fall in blood pressure, but it was no greater than that produced by an extract of the same amount of normal blood.

When an animal with a low blood pressure, the result of hammering the limb, was bled, the further loss of a relatively small amount of blood, usually 100 to 200 cubic centimeters, produced death. However, when the blood pressure was equally low as a result of repeated injections of histamine, a proportionally very much larger amount of blood could be withdrawn before death ensued. Thus a 17 kilogram dog the systolic pressure of which had been kept at or below 60 millimeters of mercury for 35 minutes by 4 injections of 10 milligrams of histamine at 10 minute intervals was then bled 615 cubic centimeters before death occurred. These findings fail to demonstrate that either hemolyzed extravasated blood returning to the circulation or a toxin is the explanation of the low blood pressure of the traumatized animal and favor hemorrhage as the cause.

It has been claimed that circulatory failure, the result of shock, will not respond to blood transfusion whereas a low blood pressure, the result of hemorrhage, may ordinarily be restored to normal by blood transfusion. In order to test by this criterion whether or not the circulatory failure produced by traumatism of a leg was due to "shock" or hemorrhage, two such traumatized animals were treated by blood transfusion and it was found to restore the failing circulation in both cases. Figure 3 shows the blood pressure tracing of a 10 kilogram dog the limb of which was severely hammered, at the beginning of which time the systolic blood pressure registered 130 millimeters of mercury. There was a rapid decline in pressure which remained low, and both heart beat and respiration ceased in 31 minutes. A transfusion of 500 cubic centimeters of heparinized blood was given immediately and artificial respiration was practiced

TABLE I—COMPARISON OF EFFECTS OF TRAUMATISM OF LEG WITH EFFECTS OF HÆMORRHAGE IN DOGS OF THE SAME WEIGHT

Wt of dogs (kg)	Estimated blood vol of body wt	Dogs dying from hemorrhage		Dogs dying from traumatizing leg	
		Bled from femoral artery (c cm)	Percentage of total blood	Difference between norm and traumatized legs (gms)	Percentage of total blood
9	693	320	46 0	436	59 6
10	770	358	46 0	400	52 0
11	847	380	44 0	355	41 9
13	1001	525	52 5	540	54 0
15	1155	519	45 0	683	59 2
16	1272	575	45 0	705	55 4

for a minute and a half. The pulse and respirations were restored and the blood pressure promptly returned to the original level. However, it was found that if the limb of a dog is traumatized until there is a marked fall in blood pressure and the animal is left in this condition for a considerable length of time, the pressure may be restored practically to normal limits by blood transfusion, but the animal will not regain consciousness. The same is true after bleeding. This is due to the fact that the cerebral centers are affected by the deficient circulation quicker than the circulatory and respiratory centers in the medulla and are killed while the latter remain alive. Death of the cerebral centers before the medullary centers is sometimes seen as a result of circulatory failure during operations in man.

In order to determine whether or not toxic substances were formed in devitalized muscle which gave rise to shock the entire right rectus abdominis muscle was excised aseptically and reimplanted in three dogs, intraperitoneally in two and into its bed in one. The animals were observed for 3 weeks after operation and showed no signs of intoxication.

#### HÆMORRHAGE

The theory that circulatory failure in traumatized limbs is due to hæmorrhage was tested by looking for evidences of loss of blood and by comparing the effects of traumatism with those produced by bleeding alone.

TABLE II—RFD BLOOD COUNTS IN CIRCULATORY FAILURE

Onset of experiment	Histamine injections Exp 231 wt of dog 9.5 kg		Hæmorrhage Exp 258 wt of dog 19 kg		Trauma to leg Exp 243 wt of dog 11 kg	
	Arterial	Venous	Arterial	Venous	Arterial	Venous
	5760000	6100000	5530000	5990000	5220000	5320000
10 min. later	6080000	6410000	5160000	5280000	5230000	5330000
	Injection 10 mg histamine		200 c cm blood from femoral artery		50 severe blows to leg	
10 min. later	5160000	5020000	5150000	5090000	4730000	4320000
10 min. later	6060000	6420000	4030000	4980000	3980000	4690000
	Injection 10 mg histamine		200 c cm blood from femoral artery		50 severe blows to leg	
10 min. later	8400000	6650000	3790000	4290000	3600000	3370000
10 min. later	8250000	8750000	3110000	3190000	3340000	3900000

It was observed that as the limbs were banded, usually at 15 minute intervals, they swelled, and this swelling increased after the banding was stopped. The amount of increase in limb volume was determined after death by making symmetrical amputations of the lower extremities along their lines of attachment to the innominate bones, and comparing their weights. It was noted that the increase in weight of the traumatized limb ranged from 310 grams in a 7 kilogram dog to 1057 grams in a 20 kilogram dog. The average increase in weight in 38 experiments in which the animals lived varying periods from  $\frac{1}{2}$  hour to 8 hours was somewhat more than that of the blood which, if withdrawn at repeated intervals during a similar period from animals of the same weight, will result in death as shown in Table I. The general symptoms developing in the animals with extensively traumatized limbs were observed and were found to be practically the same as those which occur after hæmorrhage. Severe traumatism produces acceleration of the pulse and of respiration coming on with the fall in blood

pressure When the blood pressure is as low as 80 millimeters of mercury, the pulse rate is usually 160 or higher and the respirations which vary much with the anæsthesia are 30 to 50 per minute The temperature usually falls from 1 to 3 degrees C and the mucous membranes become pale Examination of the circulating blood shows increasing evidences of acute anemia which parallel fairly closely those in other dogs obtained by repeated bleedings which lowered the blood pressure to the same level (Table II) When the blood pressure stays below 70 to 80 for some time, the animal is profoundly unconscious and usually remains so after ether is withdrawn The reflexes gradually diminish and toward the end of experiments, lasting 3 to 4 hours, are usually abolished At necropsy the general signs of hemorrhage are found The mucous membranes, serous surfaces, and viscera are pale, the heart and large veins contain relatively small amounts of blood and as previously mentioned, the intestines are pale and free from engorgement with blood

The swelling of the traumatized limbs was the result of both hemorrhage and edema, and dissections were made in order to determine the relative amounts present of each The muscles of the thigh were usually found markedly macerated, and there was extensive extravasation of blood which infiltrated both the muscles and the intermuscular septa and formed large collections in the torn regions Numerous small blood vessels were torn and in instances some of the larger ones, but it was exceptional to find the femoral artery severed The amount of edema was relatively small in comparison with the hemorrhage Microscopic examination was made of the tissues in a number of experiments It was found that in some regions the muscle was fairly well preserved, while in others it was macerated Blood extravasation was marked, especially along the fascial planes and muscle sheaths Many of the muscle fibers appeared normal The striations were present and nuclei were well stained The outstanding cause of the swelling was the hemorrhage although grossly a moderate amount of edema was always evident

Much of the extravasated blood was clotted, but an observation made by one of us

(E P) was the large amount of unclotted blood which was frequently found at necropsy hours after the limb had first been traumatized Samples collected in test tubes usually remained unclotted for days An erythrocyte count of the extravasated blood usually showed fewer cells than the capillary blood at a time when the pressure was low In one experiment there were 2,380,000 erythrocytes in the extravasated blood, while that from the ear contained 3,110,000 at a time when the blood pressure measured 33 millimeters of mercury An analysis of the plasma of the extravasated blood showed that there had been considerable hemolysis Thus in one experiment there was 8.5 grams per 100 cubic centimeters of hemoglobin in the centrifuged plasma The total hemoglobin content was usually near that of the venous blood The extravasated blood differs in different regions according to the time in the course of the experiment when it was extravasated The early extravasations consist of blood that is high in hemoglobin and red cells while later extravasations are more dilute The edema also produces still further dilution and the greater the hemolysis the lower the red count

In view of the previously mentioned vasodilator effects of hemolyzed and traumatized bloods, this marked hemolysis of the extravasated blood deserves careful consideration as a cause of lowered blood pressure However, Sellards and Minot injected the supernatant fluid from 30 cubic centimeters of packed red blood cells which were hemolyzed by the addition of water, then centrifuged and rendered isotonic by the addition of sodium chloride It produced no fall in blood pressure Bayliss showed that large quantities, 200 to 300 cubic centimeters of a dog's blood, can be withdrawn, defibrinated, hemolyzed, and re-injected without producing toxic effects or lowering blood pressure We have withdrawn 200 to 400 cubic centimeters of blood and replaced it by an equal amount of hemolyzed blood without causing any permanent lowering of the blood pressure

The cause of the failure of the extravasated blood to clot has not been determined definitely Chemically no fibrinogen could



Fig. 3 The response following blood transfusion shows that the circulatory failure was due to hæmorrhage

be demonstrated by precipitation with the addition of a saturated solution of sodium chloride to the plasma. The blood did not clot when calcium salts or blood serum was added although circulating blood of the same animal from the heart immediately before or after death always clotted in normal time. The addition of a small amount of circulating blood to it caused the formation of a jelly like clot. It was thought that an anticoagulant of the nature of heparin might be formed. Consequently unclotted extravasated blood and traumatized muscle were extracted for heparin by the method of Howell, but none was found. Heparin has not been demonstrated in normal muscle. This same phenomenon is observed in man in whom large hæmatomata sometimes remain largely unclotted for days.

In a series of seven animals, a constrictor was applied to the limb arresting circulation, after which it was traumatized. No swelling or fall in blood pressure followed. Upon removal of the constrictor the blood pressure fell, but measurement of limb volume and dissection of the limb showed that there was increase in limb volume and hæmorrhage into it similar to that which was observed in case of traumatism in the absence of a constrictor. In two experiments the femoral artery was tied before traumatization of the limb, and only a small amount of swelling and little or no fall in blood pressure resulted. However, on release of the ligature the limb swelled, the blood pressure fell, and marked hæmorrhage occurred into the limb. In two experiments the femoral vein was ligated and the limb was then hammered. This resulted in more rapid

swelling and fall in pressure than was the case when the vein was not ligated.

Death from hæmorrhage into the tissues of the limbs without a break in the skin has been observed many times in man. Larkin recently reported 4 cases of this type. It is most often seen in crushing injuries of the thighs where large quantities of blood may be extravasated without the development of sufficient tension in the soft parts to arrest bleeding.

Hæmorrhage in man may occasionally be extensive and produce marked symptoms of circulatory failure with lowering of blood pressure but with little or no compensatory acceleration of rate of either pulse or respiration. This is sometimes seen in ruptured tubal pregnancy. That it may occur in extremity lesions is illustrated by the following case.

A woman, aged 22, was operated on under ethylene anaesthesia for a large hæmangioma of the gluteus maximus muscle. A large amount of blood was lost during the excision which was done in 1 hour. Fifteen minutes later the patient was pale, very weak and restless and sighed frequently. The systolic blood pressure was 46 millimeters mercury. The pulse was very weak but its rate was 76 and the respirations were 16 per minute. After 1200 cubic centimeters of physiological salt solution had been given intravenously the blood pressure remained around 60 for one half hour but the pulse and respiration rates changed very little. The blood pressure gradually went up to 110 during the next 8 hours and the pulse went up to 90 but respirations remained around normal. That a severe hæmorrhage took place was shown by a blood examination on the third day which revealed 2,700,000 reds, 48 per cent hæmoglobin, and 12,000 whites.

The observation of such cases proves that the rule to the effect that low blood pressure

accompanied by a slow pulse indicates shock while low blood pressure accompanied by a rapid pulse indicates hemorrhage, does not hold

#### FAT EMBOLISM

In 10 experiments in which the limbs were hammered, sections of the lungs were stained for fat with scarlet red and hematoxylin. In 7 cases very slight fat embolism was found but in 3 there was a moderate amount. The quantity of fat was greatest in the experiments of long duration. Sections of the heart, liver, kidney, and spleen were made in 7 cases and extremely little to no fat was found in any of them. In 4 cases the central nervous system was examined for fat because of Porter's view that shock may result in fat embolism producing paralysis of the visomotor center of the medulla. Death occurred in 39, 40, 105, and 135 minutes respectively after hammering and in the last 3 experiments bones were intentionally broken thereby adding another factor favorable to the development of fat embolism. Sections were made of cerebrum, cerebellum, and medulla, and practically no fat was found in the vessels of any of them. The fat that was present in the lungs of some of the dogs may have been a minor factor in causing the fall of blood pressure, but that in the nervous system was too scanty to have played a rôle in any case.

#### ABDOMINAL EXPERIMENTS

While a discussion of circulatory failure from injuries and operations on the abdomen lies outside the scope of this paper, it should be mentioned that the causes are not identical with those of circulatory failure in traumatized limbs in that hemorrhage may be entirely absent in the former. This had been noted clinically in some cases. In dogs the blood pressure can usually be caused to fall markedly in  $1\frac{1}{2}$  to 2 hours by exposure and oft repeated manipulations of the intestines, and if the procedure is continued death eventually ensues. Experiments are being conducted in an endeavor to determine the cause of the fall in pressure. That it is not due to vasodilation and severe "bleeding into the intestinal vessels" as often claimed, was demonstrated in 7 experiments in which the eviscerated dogs

were periodically placed in the upright position and intestinal volume measured by immersion in physiological salt solution. Five of the animals died in from  $2\frac{1}{2}$  to 9 hours, the average being 5 hours and 10 minutes. The increase in gut volume ranged from no cubic centimeter to 230 cubic centimeters, the average amounting to 76 cubic centimeters. At necropsy, the increase in volume was found to be due partly to edema and partly to vascular congestion and ecchymosis. In no case was the amount of blood accumulating in the loops during the experiment sufficient to produce an appreciable decline in the circulation. With the great majority of individual manipulations, there was no change in blood pressure and in no instance was there a rise. In two experiments there was occasionally a sharp fall in blood pressure at the onset of the manipulation with recovery in  $\frac{1}{2}$  to 1 minute—a change in blood pressure similar to that after a small injection of histamine. This finding has raised the question of the escape of a vasodilator substance from the manipulated intestines into the circulation, but it has occurred so rarely that it cannot be looked upon as a constant factor producing the circulatory failure. Disturbances in the visomotor nervous control appeared to be a more plausible factor here than in case of low blood pressure due to traumatism of the extremities.

#### CONCLUSIONS

1. Traumatism of a limb of a dog producing fall in blood pressure is accompanied by a corresponding increase in limb volume and anemia which are due very largely to hemorrhage into the damaged tissues. This is the predominant factor in the production of the circulatory failure. Much of the extravasated blood fails to clot.

2. In these experiments it could not be demonstrated that a toxic substance liberated from damaged or asphyxiated tissues or extravasated blood of the limb was absorbed and produced a sustained fall in the general blood pressure. Therefore, the circulatory failure cannot be regarded as essentially a traumatic toxemia.

3. There is no indication of the escape into the general circulation of a toxic blood

pressure lowering substance after release of a constrictor applied for 15 minutes to the thigh of man containing its normal content of blood

4 Reflex vasomotor paralysis or exhaustion did not account for the circulatory failure, since intensive stimulation of somatic nerves produced elevation instead of fall in blood pressure, and equal amounts of traumatism to denervated and innervated extremities produced the same amount of fall in pressure in each

5 Fat embolism played either no rôle or an extremely minor one in the production of the circulatory failure

6 It is preferable to speak of hæmorrhage rather than shock or shock due to hæmorrhage when acute loss of blood in wounds, whether closed or open, is the cause of marked circulatory embarrassment or failure

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## THE INFLUENCE OF THE TRANSVERSE UPPER ABDOMINAL INCISION ON THE INCIDENCE OF POSTOPERATIVE PULMONARY COMPLICATIONS

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POSTOPERATIVE pulmonary complications rank high among the major hazards of abdominal surgery. They may occur when least expected and despite every reasonable precaution, or a smooth recovery may follow operation under conditions which appear to be most favorable for the onset of a pulmonary lesion. Because of the uncertainty in incidence, the difficult problem of prevention and treatment, and the serious consequences of many of these complications, they are a source of constant dread to the surgeon. They constitute one of the main obstacles to his free assurance to the patient about the risks of operation. Death from a pulmonary complication in a healthy patient following an operation of election is one of the most distressing experiences in surgical practice. Much interest has been manifested in the subject, especially during the past decade, and several excellent studies on etiology and prevention have pointed the way to a reduction in incidence. But a satisfactory minimum is yet far short of attainment.

Examination of the statistics on several large series of cases from different sources (Whipple, Cleveland Decker, Cutler and Hunt Mandl, Llwyn) reveals considerable variation in incidence which, however, attains an average of about 25 to 35 per cent. Decker states that 1 patient in 45 operated upon develops a respiratory tract lesion and 1 in 200 dies from the complication. It is noteworthy that in successive series reported from the same source, the incidence tends to rise, due probably to better recognition of these conditions. Whipple's interest in the subject was stimulated by noting that many cases showing a sharp rise in temperature on the first or second postoperative day exhibited characteristic roentgen ray findings before any physical signs could be detected. Furthermore he noted that the physical signs might not appear even until after the temperature

had subsided. There is little question but that many postoperative pulmonary lesions have been and constantly are being overlooked because we have been content to accept the indefinite designation of "postoperative reaction."

We are just emerging from a period in which many postoperative pulmonary complications, unless due to such obvious gross lesions as massive embolism and infarction, were loosely designated as "postoperative pneumonia." Discussions on etiology have been fraught with much speculation and there are wide differences in opinion as to the cause and manner of production in a great many of these lesions. Unfortunately, the facts in any case often permit such varied interpretations in theory that we are unable to say by what mechanism the complication has come about. Solution of the difficulty awaits more accurate methods of investigation. Recently, however, there has been a distinct effort to avoid the loose designation of "postoperative pneumonia" and to classify these pulmonary lesions more accurately as pathological entities which we are able to recognize in many instances, such as true pneumonia, embolism, atelectasis, or a combination of these conditions. Thus the ends of prevention and treatment are better served by the effort to determine the route and manner of origin in each instance.

There are undoubtedly many different factors either directly responsible for, or contributory to, the onset of pulmonary complications. It is very difficult to estimate how great a rôle any one factor may play. For many years the irritating effects of inhalation anesthetics and the frequent lack of skill with which they were administered have received much of the blame. Cutler has been a notable exponent of the theory of embolism from the operative field as being responsible for the majority of these complications. Wharton

and Pierson conclude that embolism is responsible for fully 50 per cent of the postoperative pulmonary complications following gynecologic and abdominal operations. Whipple has well summarized the factors predisposing to postoperative pneumonitis as upper respiratory inflammation, local or general infection, lowered immunity, increased virulence of organisms, and inhibition of normal respiratory movements. In recent years pulmonary atelectasis has assumed an important place in the field of postoperative complications. The condition has been known to medicine for a long period. The literature has been growing rapidly and contains many excellent reviews of its history and experimental and clinical aspects (Coryllos and Birnbaum, Lee, et al, Mastics, et al, Scott, and others). There is not universal agreement as to the manner of the production in all cases. However, it has been repeatedly demonstrated both experimentally and clinically that bronchial obstruction by mucus or foreign body with absorption of the imprisoned air is a very frequent, if not the most common, cause. Those factors which tend to interfere with respiratory function and the expulsion of mucus by coughing undoubtedly favor the occurrence of this condition. Recently Coryllos and Birnbaum have made a very suggestive case for atelectasis as a mechanism of importance in the onset of pneumonia including the postoperative type. Elwyn (8) and others are inclined to the same view.

If one examines further the statistics on the incidence of postoperative pulmonary complications, some striking and important features stand out. There is a great predominance of these lesions following abdominal incision as compared with operations elsewhere. Furthermore, the percentage runs much higher in upper abdominal operations and the pulmonary lesion is located more commonly on the right side at the base which corresponds with the greater frequency of right-sided incisions in the upper abdomen. The figures of Elwyn (8) bring out these points clearly. In a series of 2,932 operations under general anesthesia, the incidence of postoperative pneumonia was 2.76 per cent. The incidence following laparotomy was 6.29 per cent,

whereas after operation on other parts of the body it was 0.70 per cent. Following stomach operations the percentage was 13.8 per cent. He quotes the figures of Mandl who noted 10.57 per cent following operations on the stomach. The right lower lobe was involved in 41 of 89 cases, the left lower lobe in 21, both lower lobes in 24, the right upper lobe in 1, right upper and right lower lobes in 1, and right upper and both lower lobes in 1 case. Another series of cases by the same author as well as figures from other sources essentially confirm the above findings.

It has been noted, furthermore, that the incidence of complications following local anesthesia is quite comparable to that after general anesthesia. It must be said, however, that many patients are selected for local anesthesia because of poor condition and especially the presence of some factor predisposing to a pulmonary complication.

The foregoing considerations lead to the inevitable conclusion that incision and manipulation in the abdomen, especially its upper portion, are frequent and very important factors in the onset of postoperative pulmonary complications. In setting forth the contributory factors previously mentioned, Whipple characterizes the influence of the operation as follows:

"Factors inhibiting the normal thoracic and abdominal respiratory movements and favoring atelectasis and hypostasis in the lungs. (a) Trauma to the thoracic and abdominal wall incident to the incision and retraction of the operation causes persistent pain and a splinting of the thoracic or the abdominal muscles of respiration, (b) inflammation of the peritoneum causes the same splinting of respiratory muscles, (c) distention following peritonitis and coeliotomy. This causes a limitation of the diaphragmatic excursion, (d) tight binders and surgical dressings.

"These factors are undoubtedly very marked and account for the very large percentage of pneumonias associated with coeliotomies as compared to operations on the extremities. In this series 88 of the 97 pneumonitis cases followed abdominal incision. Czerny was the first to emphasize the role of pain in the abdominal wound as a factor in

preventing sufficient aeration of the lungs and expectoration of mucus in the trachea."

The writers have felt that the influences just mentioned have not received sufficient consideration. In search of some way to modify and lessen this "wound effect" on respiratory function and thereby possibly to lower the incidence of pulmonary complications, it was decided to try the transverse upper abdominal incision in every case in which it was feasible. This incision is well known and has been practiced by many surgeons for various reasons but often with little or no emphasis as to its effect on respiratory function. However, from this standpoint alone, sound physiological principles recommend it.

Transverse incisions early were used for cosmetic effect, as they left a thin unobtrusive scar. At this time the only structures divided transversely were the skin and subcutaneous tissue, the deeper layers being separated by a vertical incision. Moore gives to Maylard the credit for originating the transverse division of all layers of the abdominal wall. Spengel, however, early became the foremost advocate of the transverse incision pointing out its many advantages. His writing stimulated the interest of Moschcowitz who in 1916 reported his experience with 97 cases and included a comprehensive account of the anatomical and physiological principles involved. The three great flat abdominal muscles, the external and internal oblique and transversalis, have a wide attachment of origin over the lateral and posterior aspects of the trunk. They have a common insertion in a broad aponeurosis passing posterior to the rectus abdominis and interlacing in the midline with a similar structure on the other side to form the linea alba. This aponeurotic insertion is made up of a multitude of fine tendinous fibers having in general a transverse direction. The term "posterior sheath of the rectus" tends to divert attention from the real importance of this aponeurosis which has little significance so far as the rectus itself is concerned, but is of great importance as the structure of insertion of these flat abdominal muscles. The direction of their action varies some in each case but the general effect of all is a lateral pull.

As Moschcowitz points out, the conventional vertical incision violates sound anatomical and physiological principles. Every surgeon sooner or later has a practical demonstration of the fact in the exasperating experience of closing a vertical incision in the upper abdomen especially if the patient strains or is rigid. The flat muscles pull the wound apart and the sutures tear out because they are placed parallel to the majority of the aponeurotic fibers which have been divided transversely. When closure is finally accomplished the sutures probably often pull out in the first few postoperative hours especially if there is any straining or retching. This is very apt to result in massive adhesions and a weak wound.

Many surgeons in addition to those mentioned have recorded their experiences with the transverse incision (Bakes, Meyer, Quain, Perthes). Practically all are agreed that the technique of incision is more tedious and complicated than in the vertical wound. This is more than compensated for, however, by the ease of closure. Straining actually makes suture easier as the lateral pull of the flat muscles tends to approximate the wound edges. Many surgeons have emphasized the superior access which the transverse wound affords in stomach and gall bladder operations. With this the writers cannot agree entirely, as the upper "shelf" of the wound is an obstacle in the approach to a high deep gall bladder. But more troublesome than this in many cases is the difficulty of access to the common bile duct because the upper "shelf" may interfere greatly with the passage of exploratory probes, forceps, etc. In most of the cases, however, exposure is entirely adequate. It is necessary only rarely but perfectly justifiable to make a vertical prolongation upward or downward at the inner extremity of the wound or to divide both rectus muscles. There is universal approval of the cosmetic result, which is a thin and sometimes scarcely perceptible scar. The late results have shown a low incidence of hernia which usually occurs only when there has been extensive sepsis and necrosis. Of the 97 cases reported by Moschcowitz, 67 were available for examination at the end of

a few months to about 6 years. No hernia was found. It has been pointed out that ventral hernia in a transverse wound is difficult to repair. Sufficient time has not elapsed to report the late results in the cases of this series. To date hernia has been observed in only 1 case. Some operators have objected to the unsurgical practice of dividing the rectus muscle. This apparently does no harm whatever, as subsequent operation has demonstrated that the scar really amounts only to an extra transverse line.

Of all the advantages, however, the one which seems the most significant is the freedom from wound pain pointed out by other observers and the ease of breathing as compared with that in patients in whom the vertical incision has been used. This again is logical from the point of view of anatomy and physiology, because the pull of the great abdominal respiratory muscles tends to approximate and relax the wound and not pull it apart. This must lessen the pain and therefore permit more nearly normal respiratory excursion and lung ventilation. Impressions gained from close observation of these patients have confirmed this view in practically every instance. It is striking to note the comfort and ease of breathing in the average short, obese, patient following a gall-bladder operation with transverse incision. Such a patient with vertical incision often gives the impression of extreme discomfort for the first 2 or 3 days, with elevated and restricted or "grunting" respirations and a flushed or slightly cyanotic face. This restricted respiratory excursion, limited lung ventilation, and tendency to voluntary restraint of cough undoubtedly impose conditions favorable to the onset of atelectasis and pneumonia. With the transverse incision, cough and other expulsive efforts are often notably less painful.

This highly probable relationship between the "wound effect" and the complications of atelectasis and pneumonia cannot, however, be extended so obviously to pulmonary embolism. The problem of embolism cannot be discussed at length but many additional factors, the nature and operation of which are still obscure, come into play. It is commonly

believed, however, that venous stasis is an important element in the formation of emboli. It is also well known that normal respiratory motion plays a rôle in the return of venous blood to the heart. In so far as this motion is restricted, it might operate with other factors to promote venous stasis and thus increase the tendency to embolus formation. But the relationship between embolism and the "wound effect" is certainly less obvious and important than in the case of the two other major pulmonary complications.

The transverse upper abdominal incision has been used in a series of 125 cases, most of which were operations on the gall bladder, bile ducts, and stomach. In 2 or 3 cases, pulmonary symptoms, such as cough of mild or moderate intensity, were noted without other evidence definitely to establish a pulmonary complication. In 5 cases there were definite pulmonary complications all due to embolism. There were 2 fatalities in which the diagnosis was confirmed at autopsy. In the remaining cases, the onset and course were typical of embolism and infarction with satisfactory recovery. The occurrence of embolism in this series is rather striking, but undoubtedly is to be explained only by factors which lie without the scope of this discussion. It is equally striking that no cases of atelectasis or pneumonia were observed. Thus the total incidence is 4 per cent, notably less than Elwyn's report of 6.29 per cent for all laparotomies and in marked contrast to his figure of 13.8 per cent following operations upon the stomach. When one considers that in the selected group of upper abdominal operations in which the pulmonary complications are highest and that, including the cases of embolism (100 per cent) in this series, they are reduced by 50 per cent or more, it would seem that the foregoing principles have an important significance.

The technique of the incision has been described many times and will be reviewed briefly. The skin and subcutaneous tissue are divided straight across from the midline or slightly beyond to a point which makes the incision lie tangent to, or slightly above, the inferior curvature of the costal margin. At the outer border of the rectus, the flat muscles

are divided in the direction of their fibers and an opening is made into the peritoneum sufficient to admit the forefinger. With the finger in the peritoneal cavity to protect the viscera, two mattress sutures of No. 1 chromic catgut doubled are placed on either side of the incision. These sutures pass through the anterior rectus sheath, the muscle, the peritoneum, and out again. The ends are snapped and held. The muscle is then divided between these sutures securing and ligating vessels before severing the posterior sheath and peritoneum. In closure the posterior sheath and peritoneum are united with a continuous suture of No. 1 chromic catgut and next the anterior sheath in the same manner. Particular care should be exercised to get good closure at the inner extremity of the wound where all structures unite in a single layer. Next, the corresponding ends of the doubled mattress sutures are tied across the incision and the skin is closed. If a drain is used it emerges at an advantageous point in the outer extremity of the wound. As has been mentioned, both rectus muscles may be divided or a vertical extension may be made up or down from the inner extremity of the incision. These modifications are rarely necessary in operation on the gall bladder and bile ducts, but may facilitate such operations as resection of the stomach or splenectomy.

It is realized, of course, that the number of cases is far too small to warrant final conclusions as to the value of the transverse upper abdominal incision in the limitation of postoperative pulmonary complications. The evidence presented cannot be considered otherwise than a strong impression created by clinical observation. But the impression is so suggestive that the transverse upper abdominal incision will continue to be used in every case possible, despite the handicaps which have been noted, until sufficient evi-

dence has accumulated to establish or disprove definitely the relationship which is now indicated.

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## RENAL RESECTION, AN EXPERIMENTAL STUDY OF POST-OPERATIVE FUNCTION

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SINCE Valentin first nephrectomized eight rabbits in 1839, and Tuffier (1889) made a surgical study of the animal kidney, much experimental work has been done on the kidney as a whole as well as on a portion of the renal parenchyma. However, little attention has been given to the post-operative function of the resected kidney, especially as regards phenolsulphonephthalein output.

The object of the present work was to investigate, experimentally in animals, various types of technique in renal resection, to observe the incidence of hæmorrhage, fistula, atrophy, and compensatory hypertrophy, and to determine the renal function following resections as evidenced by the excretion of phthalein.

The kidney was resected under healthy conditions and without disturbing the opposite kidney. Not enough renal substance was excised to disturb the renal counterbalance (if this occurs) and stimulate compensatory hypertrophy. Theoretically our results should show a parallelism between loss of renal substance and loss of renal function.

### METHODS

Thirty-seven dogs were used in these experiments. Of these 2 died under ether narcosis, one from postoperative hæmorrhage and one from peritonitis. Our greatest difficulty after operative recovery was to keep the animals alive and healthy for any great length of time, for they seemed to suffer an increased susceptibility to infection of the air passages.

The dogs were anesthetized with ether, and the oblique lumbar incision was used to reach the left kidney. The kidney was delivered, the upper pole decapsulated, and then excised by a wedge-shaped incision. If the renal pelvis was opened it was closed with catgut sutures when convenient, otherwise not, since we did not consider it necessary. With an open healthy urinary tract we never saw

fistula develop. The capsule was drawn together over the resected end and the renal wound was closed by simple through-and-through sutures of No. 1 catgut, fused in the end of a straight intestinal needle and vaselined. The abdominal wound was closed in the usual way without drainage, and the skin was sutured.

This technique was adopted after a rather painstaking investigation of many methods, particularly the following. The kidney was resected straight across, by a V-shaped incision, with and without stripping the capsule. The V-shaped incision after the capsule was stripped gave the best results. The kidney wound was closed in many different ways: mattress sutures, through-and-through sutures, ligature of individual cut vessels, circular suture of cut surfaces, compression without suture, fat masses under sutures, capsule alone sutured, etc. The through-and-through simple suture as advised by Tuffier after the stripped capsule had been replaced was found to be most suitable. We noticed that if placed deeply, these simple sutures stopped hæmorrhage, did not cut through the renal substance, and produced a minimum amount of atrophy. The straight needles with catgut fused in their heads produced very little trauma, especially if well greased with sterile white vaseline. It was unnecessary to suture the capsule separately. The deep sutures held it in place very well, without further aid. The capsule was of great assistance in holding the suture in place and preventing it cutting through the friable renal parenchyma, and it seemed to be a barrier to late secondary hæmorrhages. We found that mattress sutures were highly destructive to renal parenchyma and produced a maximum amount of atrophy, with a corresponding reduction in the phthalein output.

The dogs were kept for periods ranging from 1 to 34 weeks, when they were anesthetized with barbital sodium, given intravenously.

We found that barbital did not interfere with free secretion of urine, while ether often greatly retarded the output. A suprapubic cystotomy was performed, and the ureters were catheterized with Nos. 4 or 5 ureteral catheters. Water was given by stomach tube and normal saline subcutaneously in sufficient quantity to ensure free excretion of urine. Then 6 milligrams of phenolsulphonephthalein was injected intravenously and the urines collected for 1 hour. The dogs were now killed with ether and the kidneys removed, weighed and measured. The phthalein estimation was now made. The normal phthalein output for 1 hour varied somewhat, but averaged around 70 per cent (35 per cent for each kidney). Mark placed the normal at 80 per cent in 2 hours.

#### RESULTS

The function of the right, or unoperated upon kidney, remained normal after resection of the left kidney in dogs 1, 2, 3, and 5 weeks old. The dog of 5½ weeks showed an increased function to 50 per cent, which was unexplained, it weighing only 3.0 grams more than the left kidney. The 34 week dog showed normal weight and slightly reduced function (27.5 per cent). Compensatory hypertrophy did not occur. With these two exceptions the unoperated upon kidney remained normal in function and weight.

The resected left kidney showed a decrease of weight and of phthalein function in all experiments and at all times. The diminished function was most marked during the first 2 weeks after resection, due to congestion and repair processes. A gradual restoration of function occurred in the third to fifth week, never, however, reaching the normal amount. The 34 week dog showed a phthalein of 17 per cent. The weight of the operated upon kidney increased during the first 2 weeks after resection, likewise due to congestion and repair processes. After the third week the kidney slowly diminished in size and weight, until it was smaller than normal. At 34 weeks, one kidney weighed only 11 grams, about one third of normal, an unusual amount of atrophy. However, in no instance did we encounter total atrophy and complete loss of function.

Five to 10 grams of the left kidney was resected, approximately one seventh to one third of the substance of this kidney. The average amount of renal tissue removed was 6.33 grams.

The reduction in function was relatively greater (10.5 to 25 per cent phthalein), approximately one third to two thirds the normal. The average showed a phthalein on the left side of 18.7 per cent (52 per cent of the normal). This discrepancy between function and weight was due probably to operative and suture trauma and scar formation.

#### RESUME OF CASES FROM THE LITERATURE

Tuffier showed that after resection, the quantity of urine and urea temporarily diminished or ceased abruptly, then progressively increased, to regain the normal rate by the sixth day. Barth and Wolff each saw little or no hypertrophy of the opposite kidney after renal resections. Rowntree and Geraghty observed a noteworthy alteration in phthalein excretion only when disease had reduced the total kidney parenchyma to less than one half. Vigoun obtained some decrease of phthalein output after nephrotomy. Cash noted diminished phthalein excretion when the total tissue was reduced over 50 per cent.

Young and Davis obtained 5 per cent phthalein excretion from the resected left kidney and 20 per cent from the healthy right kidney, 4 months after operation, a ratio of 1 to 4. Scholl first nephrectomized a functionless right kidney for calculous pyonephrosis and later did resection of the remaining kidney for nephrolithiasis. At the time of resection the phthalein was 40 per cent. One year later the phthalein had risen from a post-operative 15 per cent to 50 per cent. Beer did a wide heminephrectomy, and one year later the phthalein output of the two kidneys was 15.4 to 7.

Spiegelberg is said to have resected a kidney for hydatid cyst in 1867 (deRouville). Spencer Wells (1884) excised one third of the left kidney during the removal of a perirenal fibrolipoma. Czerny (1887) resected for localized angiosarcoma, and Tuffier (1891) for a cyst and a renal fistula. Keetly (1890) resected part of a traumatized kidney, and

Bardenhauer (1891) resected for a renal cyst, traumatism, and lithiasis

Pawlik (1896) was the first partially to nephrectomize a double kidney Israel, Cramer, and Watson (1896) each resected regions of localized tuberculosis Kuemmel (1890-1895) did resection for calculous pyonephrosis, echinococcus cyst, malignant tumor, horseshoe kidney, and for diagnosis Bloch (1898) used resection as a diagnostic procedure Tuffier, Chavannez and Lefevre resected the polycystic kidney Among the early cases in this country are three by W J Mayo, reported by Braasch in 1912

Bloch collected 10 cases in 1896 and Berti in 1921 collected 113 Since Berti's report we have found an additional 109 cases of resection, making at least 222 cases up to 1928

#### INDICATIONS

Renal resection is conservative surgery and may be utilized in certain types of renal pathology It is indicated when the pathology is localized and benign, the blood supply to the resected kidney adequate, and the operation anatomically possible It has been practiced in the presence of cysts, benign tumors, double kidney, nephrolithiasis, partial hydronephrosis and pyonephrosis, renal fistula, infarct, localized cortical infection, paranephritic disease, horseshoe kidney, tuberculosis, and to establish a diagnosis

Among the many indications, renal resection is particularly valuable in calculous disease

Given a case in which a stone or stones occupy one pole of the kidney, with more or less dilatation of the calyces or destruction of the parenchyma with cavity formation, the removal of the involved segment of the kidney is likely to give a better result than pyelotomy or nephrotomy, particularly because it eliminates the possibility of recurrence

Resection of the infected part of a double kidney, if the anatomical arrangement of the circulation permits, offers an interesting field in conservative surgery

In the correction of ectopic ureters, resection of the kidney or part of the kidney supplying such a ureter is without question the operation of choice, provided the circulation permits

In solitary cyst of the kidney, the question comes up as to whether or not it is better to take a wedge-shaped piece of renal parenchyma with the cyst, and in this way obtain better closure of the wound with less danger of hemorrhage

The use of resection in the more unusual conditions of benign tumors and localized hydronephrosis warrants consideration Whether it should ever be practiced in tuberculosis or malignant disease is a question, but one may feel justified in doing the operation even here, provided the conservation of renal tissue offers a better chance for the patient

When dealing with the same type of disease, it is usually conceded that nephrectomy carries a higher mortality than resection

#### CONCLUSIONS

Resection of the kidney in the dog reduces the weight and phthalein function in all cases and at all times A return to normal does not occur in a 34 week period, probably never

Function decreases approximately in proportion to the loss of secreting renal tissue Even small amounts removed will cause loss of renal weight and function Scar formation and circulatory disturbances by suture constriction always increase the loss of renal parenchyma

Resection of small amounts of renal substance does not affect the life or health of the dog and does not cause compensatory hypertrophy of either the resected or the opposite healthy kidney, as evidenced by the weights and functional tests in our experiments

Both function and parenchyma seem to be present in excess of the animal's healthy needs, since considerable amounts may be removed without evidence of compensatory hypertrophy or disturbance of health

Complete atrophy and complete loss of function of the resected kidney did not occur in 34 weeks, although there was always some reduction of weight and size—a relative atrophy Disuse atrophy was never observed

Renal fistula did not occur and post-operative hemorrhage was rare

There is little question that the unfounded fear of hemorrhage and leakage of urine



following renal resection has had much to do with the unpopularity of this valuable procedure. Leakage did not occur in any of the 37 dogs operated upon and hæmorrhage occurred only once, and in this case it was due to failure to obtain good hæmostasis, because of hurry on the part of the operator, with resultant poor technique. Late hæmorrhage was never encountered.

Since Spiegelberg in 1867, and Spencer Wells in 1884, first resected the human kidney, at least 222 resections have been done for various forms of localized renal pathology (up to 1928). It seems appropriate then to remind the surgeon that after simple renal resection, there may be a loss of function in the resected kidney, dependent upon the amount of parenchyma removed. Considerable renal function will nevertheless have been saved, and may give valuable service to the patient should he ever require it.

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A USEFUL SEMI-ANÆSTHESIA FROM LUMINAL<sup>1</sup>

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IT will be admitted by many surgeons and surely urged by most patients that both inhalation and local anæsthesia, in current practice, leave something to be desired, hence we have in this series of investigations (a) aimed particularly at the elimination of pre-operative anxiety and strain, (b) endeavored to diminish the amount and concentration of the inhalant used, (c) striven for a period of oblivion coincident with the post-operative suffering, (d) planned for the post-operative patient to drink as usual instead of receiving fluids by vicarious methods—decreased incidence of nausea making this possible

This report might not have seemed worth while if we had by our plan further complicated inducing anæsthesia, had added anything to the risk involved, or had increased the morbidity inherent to it, our experience seems, fortunately, to have run to the opposite direction

## THE PLAN

For the purpose of this study general anæsthesia is divided into two phases the first is quite satisfactorily covered by luminal, but the second, beginning with abolition of pain sense, must, to seem safe, be the result of inhalation which, being wholly under our control, can be terminated almost instantly We do not use a dose of luminal sufficient for deep surgical anæsthesia, because its effects cannot be influenced as circumstances may indicate, nor can the drug be recovered short of its 72 hour elimination period

This method of employing luminal, which is not intended as a substitute for local or general anæsthesia, greatly facilitates the use of either of them, reduces the amount required, and prolongs the effect of both (It is a simple matter to secure a luminal surgical anæsthesia, if one so desires, merely by increasing the dose We gave Mrs E, November 23, 1929, but 19½ grains then removed an enormous adenomatous thyroid though she received in addition only an infiltration of the skin incision

line supplemented by an occasional whiff of gas when extreme traction was required This amount was for her a relatively large dose)

Our records show that we have used in selected cases veronal and luminal (alone or in combination with several other sedatives) since March, 1921, as a means of anæsthesia induction in the broadest sense Rather extended mention of this experience was made in our book entitled *Surgical Treatment of Goitre*<sup>2</sup> To date we have employed one or the other of these two drugs in about 1,144 operations intended for the relief of an infinite variety of conditions, whereas we at first limited their use to toxic goiter patients Two groups of these patients will be reviewed forthwith

## SUMMARY I

This study in detail covers 99 cases operated on from May 9, 1929, to August 24, 1929

Data were gathered under the following headings (1) thyrotoxic or non-toxic, (2) blood pressure before drug was given, (3) total dose of drug (luminal or veronal) and interval between each dose, (4) blood pressure after drug was given, (5) anæsthetic—(a) general, (b) local, (c) spinal, (6) operation, nature and duration, (7) time of spontaneous awakening after operation, (8) consequences—(a) drowsy, (b) nauseated, (c) headache, (d) dizzy, (e) irrational, (f) restraint used, (g) respiration, (h) pulse

**Toxicity** Of the 99 patients 61 were not thyrotoxic and 38 were toxic

**Dosage** Luminal was given in 40 cases The usual interval was 3 hours, and 3 grains were given at a time The total dose varied from 9 to 30 grains, 7 patients had 12 grains or less, 33 had from 15 to 30 grains, but the dose most frequently given was 21 grains (18 cases)

In addition to luminal, morphine or scopolamine, or both, was given to 11 patients before operation

<sup>1</sup>Bartlett *Surgical Treatment of Goitre* pp 154-156 St Louis C V Mosby Co 1926

<sup>2</sup>From the surgical service of the Missouri Baptist Hospital Read before the Southern Surgical Association Atlanta December 12 1929

Veronal was used in 48 cases. The usual interval was 2 hours, and 5 grains was given at a time. The total dose varied from 7 1/2 to 50 grains. Nineteen patients had 35 grains or less, 29 had 40 to 50 grains but the dose most frequently given was 40 grains (23 cases).

**Blood pressure.** Readings following the drug effect (before operation) showed the following changes. There was a decrease in 49. The systolic was affected in 8, diastolic in 19, and both phases showed changes in 22 cases. 10 millimeters or less in 13, 10 to 20 millimeters in 5, and 20 millimeters or more in 11 (systolic alone in 8). There was an increase in 23. The systolic was affected in 9, diastolic in 2, and both in 12. 10 millimeters or less in 13, 10 to 20 millimeters in 5 and 20 millimeters or more in 5. No change was noted in 11.

**Mixed effects** were found in 10 (systolic increased, diastolic decreased in 3, reverse occurred in 7). The changes were not reported in 6.

In only one case was a drop in blood pressure noticeable clinically. This occurred in a chronically depleted, anæmic woman on whom total abdominal hysterectomy of 40 minutes' duration was performed under spinal anaesthesia after 21 grains of luminal had been given. She responded immediately to blood transfusion. The use of barbituric acid derivatives in conjunction with spinal anaesthesia is commented on elsewhere in this paper.

A careful study of the details of blood pressure changes reveals that simultaneous elevation of both phases occurs three times as frequently in thyrotoxic cases as in the non toxic. Lowered and unaffected readings occur equally in both toxic and non toxic cases. No variation or a change in either direction of less than 10 millimeters of mercury occurred in half of the cases in this series.

**Anaesthesia.** Nitrous oxide gas was used in 47 cases, nitrous oxide gas and local infiltration in 34 cases, ether in 8 cases, spinal infiltration in 5 cases, and local infiltration in 3 cases.

**Operations.** Thyroidectomy was performed in 61 cases (thyrotoxic 38, non toxic 23), appendectomy in 13 cases, abdominal hysterectomy in 6 cases, cholecystectomy in 4 cases, radical breast amputation in 4 cases, resection

of the stomach in 2 cases, and miscellaneous operations in 7 cases. Operation was postponed in 2 cases.

**Spontaneous awakening.** Awakening occurred in less than 1 hour in 6 cases, in 1 to 4 hours in 17 cases, in 4 to 7 hours in 28 cases, in over 7 hours in 33 cases (luminal 10, veronal 23). The period was undetermined in 15 cases.

**Consequences.** (a) Drowsiness after operation varied from mild apathy and willingness to lie quietly to deep sleep into which patient would immediately relapse after being awakened. (b) Nausea was present in 33 per cent of all, but 66 per cent of cases having morphine were nauseated. (c) Headache was present in 28 per cent but always yielded to pyramidon. (d) Dizziness was present in 30 per cent of those having luminal. It was not reported as to those having veronal. The dizziness was always mild and transient. (e) Eight per cent of patients were mildly irrational, of these, half had toxic thyroids. (f) Four per cent needed mild restraint. (g) As to pulse and (h) respiration no changes were noted other than those experienced in similar cases of each type prepared by other methods. The respiratory rate in the great majority varied from 18 to 24 after operation.

#### SUMMARY II

In this series of 65 cases between August 29, 1929, and November 30, 1929, on whom the effects of luminal were studied, the drug was given 3 hours before operation in a single dose. These patients were studied in somewhat different detail from those of the preceding series, with the following results:

**Age.** The ages varied from 11 to 70 years, largest number being in fourth decade.

**Figure.** Patients were of medium figure, 67 per cent, stout, 20 per cent, and thin, 13 per cent. In this series the patients were thyrotoxic, 53 per cent, non toxic, 47 per cent.

**Dosage.** Nineteen patients received 12 grains luminal, 16 received 15 grains, 13 received 18 grains, and 8 received 21 grains. The remaining 9 patients received from 9 to 30 grains. In addition to luminal 3 patients were given 1/4 grain morphine prior to operation.

**Effect.** Judged on patient's arrival in operating room, the effect was slight in 10 per cent,

moderate in 70 per cent, and profound in 20 per cent

*Operations* Of the 63 operations performed, 2 were postponed after luminal had been given, 35 were thyroidectomies, 20 were on the organs of the abdomen and the female pelvis, 3 were extensive dissections of the neck, and 5 are grouped as miscellaneous

*Anæsthesia* Spinal anæsthesia was induced in 3 cases, local infiltration alone in 1, and 59 inhalation anæsthetics were given, of which 39, or 66 per cent, were nitrous oxide throughout. In 8 more cases, ethylene was given for a few moments only to induce relaxation and the operation carried out thereafter under nitrous oxide. Ether was similarly employed for a few minutes in 2 cases. Ether was not used at all in any other cases. Ethylene alone was given in 8 cases and in 2 cases operations were done under combined nitrous oxide and infiltration. The cases in which nitrous oxide alone was used comprised 74 per cent of the thyroidectomies in this series and 45 per cent of all operations other than thyroidectomy.

The administration of the anæsthetic was described by the anæsthetist as being ordinary in 43 per cent, simplified in 37 per cent, and difficult in 20 per cent. It is to be emphasized that the majority of these patients are "carried," after preliminary induction, at a concentration of 20 to 60 per cent nitrous oxide.

*Morphine* We noted in each case the number of hours following operation at which the first dose of morphine was given. Five per cent of the patients received morphine before leaving the operating table, in 9 per cent the first dose was given within 4 hours, in 25 per cent between 4 and 12 hours, in 8 per cent during the second 12 hours, and 53 per cent received no morphine. Those cases in which no morphine was required included 60 per cent of the thyroidectomies (thyrotoxic with one exception) and 47 per cent of all other operations.

The number of doses of morphine ( $\frac{3}{4}$  gram in every case but one) given to each patient in the first 12 hours was noted. One dose was given in 21 per cent, 2 doses in 17 per cent, 3 doses were given in 5 per cent (all of whom were on peritonitis treatment), and in 57 per cent no morphine was given.

*Duration of effect* One cannot sharply define the time at which the effect of large doses of luminal wears off, there are several effects, in reality, which disappear at different intervals. However, the state which we have in mind as useful to our purpose is characterized by drowsiness of mild or profound degree, lack of interest in the patient's own condition and her attendants, a failure of response to any but sharp, severe pain, and a general willingness to lie quietly in whatever position she is placed. It is true that the reflexes, importantly the cough reflex, are rarely abolished, a patient with much mucus in the respiratory tract will cough it up. Patients swallow fluids quite normally when awakened for that purpose.

Of these 65 cases, the effect as understood lasted less than 4 hours in 6 per cent, between 4 and 8 hours in 10 per cent, between 8 and 12 hours in 15 per cent, between 12 and 24 hours in 36 per cent, and over 24 hours in 33 per cent. The great majority had no recollection of the events during the 24 hours following the luminal, viz, postoperative examinations, change of dressings, visits by relatives, or the arrival of special nurses. Several recalled being transferred from their beds to the cart, but few remembered being prepared in the operating room or the start of inhalation anæsthesia.

*Vomiting* Seventy per cent did not vomit during the first 12 hours after operation, 14 per cent vomited once, 7.7 per cent vomited twice, and a similar number 3 times. The remaining patient vomited 7 times.

We employ luminal as routine because (1) we find it entails less nausea and vomiting than does veronal, (2) an immense amount of clinical and experimental data concerning it are at hand, (3) there is not in the literature a single authentic record of death from luminal alone, although at least two individuals are known to have swallowed 50 grains at a dose, (4) veronal, our more favored hypnotic, has an undeservedly evil reputation as a suicide implement, especially among the lay public, (5) veronal has one especial drawback, viz, many patients will fall out of bed following its use unless some form of restraint be enforced (we employed bed "side boards" about 7 inches

high) An occasional patient is sure to be found on the floor if this precaution be neglected

Our patients are never told that luminal is the drug that has been used, in view of the habit forming potentialities involved. Most patients are aware that barbituric acid compounds are purchasable over the drug store counter, hence the precaution

*Absorption* Experience has convinced us that luminal is not absorbed from the wall of the human stomach (having found it unaltered in the vomitus of patients suffering from pyloric obstruction, after noting absence of hypnotic effect) not enough luminal to be of value was absorbed from the stomach of Mr McC (August 8, 1929) on whom resection was done for complete pyloric obstruction. It has no place in stomach surgery if one excepts the rare instances in which pyloric stenosis and retention play no rôle

In sharp contrast to the result just quoted is the effect of luminal when introduced into the cæcum. It is very similar to that following the usual oral administration. We gained much experience along this line from a 62 year old man, Mr B (October, 1929), who wore a water tight mushroom catheter in a cæcal fistula made for colon drainage and irrigation, he always seemed to react to the given dose in much the same way that one does when it is swallowed

#### INDICATIONS

One may be permitted a few random suggestions regarding the particular fields in which luminal semi-anesthesia seems to be, or not to be, particularly indicated

Luminal and nitrous oxide gas permit one to perform most of the abdominal operations with utmost facility. Not more than a 15 grain dose has even been required in non-toxic patients (with gas and occasionally a few seconds of ethylene while packing off) for cholecystectomy or for any other procedure down as far as the hysterectomy level. The abdominal wall is not so flaccid as with deep ether or spinal anesthesia, still, the field exposed is quite adequate for ordinary purposes

If extreme relaxation is essential to the success of an operation, one does well to employ

outright spinal anesthesia, as for example in coapting the margins of a large hernial opening, or when compelled to resuture an abdominal wound which has burst open

A moderate amount of abdominal exploring is quite feasible under luminal and nitrous oxide gas though the patient exhibits more reaction than is the case when spinal anesthesia is used, still, one can readily palpate a large gall stone through a low incision or locate a pelvic tumor through an opening high in the abdominal wall. It may be added with propriety that modern diagnostic methods have considerably reduced the value or necessity of the one time complete manual exploration with attendant possibility of shock

The radical breast operation is one in which luminal is particularly of value, for we feel that the field is too high for spinal anesthesia, nerve blocking is impractical, and infiltration is contra-indicated in cancer. For these reasons, one relied formerly on a deep general anesthesia in the very patient whose post-operative respiratory excursion was certain to be limited by the character of the work which had been done (pneumonia danger). Very little gas is required if 15 grains of luminal has been taken beforehand

Luminal preparation would seem to be of especial value on toxic goiter patients who must be carefully protected from every influence calculated to startle, frighten, disturb, or annoy them. While such patients remain utterly oblivious to operating room surroundings the administration of the nitrous oxide need merely be suspended for a moment and they can be aroused sufficiently during thyroidectomy for the operator to detect the need of an extra ligature, or to establish the presence of any vocal defect which may have been produced by injury to the motor nerve mechanism of the larynx

The minor anal and rectal operations, which usually require particularly deep anesthesia, can, strange to say, be done most satisfactorily under luminal and nitrous oxide gas. We have been the more impressed by this fact after our experience in treating secondary ischio-rectal abscess in heavy drinkers who had proved to be most refractory ether subjects at the time of primary operations some years earlier

It may be stated without fear of contradiction that there are two excellent reasons for stressing the use of luminal on patients who are to have local anæsthesia (1) they naturally are undisturbed after luminal by the psychic elements connected with the injection of novocain, (2) luminal (and all barbituric acid derivatives) are antagonistic in their action to novocain.

We advise caution in the use of luminal as preliminary to spinal analgesia (1) Such patients come to the table in a condition which renders them somewhat incapable of co-operating, hence a needle may be broken off by a sudden movement of the patient (2) The flow of spinal fluid is occasionally slowed beyond reasonable limits by lowered blood pressure (3) The combined lowered blood pressure produced by both methods may be embarrassing temporarily. We were for a time unable to get it at all in one case though the patient recovered after transfusion, as has been stated.

Luminal is not to be administered, of course, in any of those abdominal conditions which contra-indicate fluid by mouth, viz peritonitis, ileus, paralytic or mechanical, etc., nor in the treatment of surgical patients who are vomiting from any cause whatever.

#### DOSAGE

We have used luminal in both sexes, in patients ranging from 11 to 70 years of age and in those of every size, type, and build without having encountered an individual idiosyncrasy in anyone who has taken an amount which experience had shown to be well within safe limits.

One is aided in determining the dose of luminal for an adult by several considerations. Long use of it has shown 15 grains to be the minimum serviceable amount for non-toxic adults. This dose or less will then be given the patient who is (1) of low weight, (2) weak, (3) a good sleeper, (4) very placid, and (5) co-operative. A larger amount should be given the patient who is (1) accustomed to any sedative, (2) who has an increased metabolic rate, (3) is excitable, and (4) who is of very large size. In the extremes of age the dosage will be cut down, of course.

In order to insure the maximum rest, most toxic thyroid patients are given 4 doses (15 grains) of luminal per day upon entering our hospital service. During this period we are enabled to detect any unusual sensitiveness to the action of the drug, this is probably the one infallible guide to a correct estimate of individual requirements. If all risk of cumulative intoxication is to be avoided, these doses must be omitted for a period exceeding the 72 hours required for complete elimination before the immediate pre-operative treatment with a rather heavy dose is started.

We have learned *when* it is to be given from our experience with a few patients who have had the operation postponed after the luminal had been taken. It has been noted that they were most soundly asleep at the end of 4 or even 5 hours, hence we shall proceed in future to give the preliminary dose 3 hours before operation, if given earlier than this, too much of the desired postoperative oblivion is lost.

A semi-anæsthetic dose, not exceeding 15 grains, powdered in hot milk, may be given all at one time 3 hours before operation with good effect to a patient whose tolerance is known and who has slept well naturally or has done so on 2 to 3 drachms of paraldehyde, provided the systolic blood pressure is above 100. The advantages of this method are (1) the effect and more is thus secured on the table and continued longer than did that which followed larger amounts given in broken doses in earlier experiments, (2) the full soporific effect is obtained when most needed, (3) the cumulative risk incident to larger amounts being in the system is avoided during the 72 hours of elimination, (4) the patient is not awakened repeatedly, (5) the nurse is spared the responsibility of judging a patient's needs, as was the case when broken doses were given in the earlier series.

While our experience to date (September 1929) indicates that 15 grains of luminal is the minimum routine dose which may be given to produce an effect that can be described as profound when given to average adults, it can by no means be said to be *alone* producing an anæsthesia of a normal quality who possesses a normal tolerance for the drug, and it is *not always* as

as even preliminary for nitrous oxide anesthesia on a toxic thyroid patient

The toxic goiter patient, as we long ago learned, rapidly oxidizes every sedative, hypnotic, and anæsthetic drug, hence it is futile and unsatisfactory to expect of her a physiological response to the amount of luminal suited to an individual with normal metabolism. We have given 18 grains if the basal metabolic rate has slightly exceeded +20, 21 grains if it has approximated +35, 24 grains if it has been near +50, and 27 grains if the patient has seemed particularly unruly, though we have occasionally used 30 grains. We do not advise the use of more than 15 grains at one dose under any circumstance. A larger amount should be given in broken doses over a period of 12 to 18 hours while one is on the lookout for toxic symptoms, thus carrying out a tolerance test. But if, after all, the admitted variation in personal tolerance to luminal (as to other hypnotic drugs) leads now and then to underdosage first discovered on the operating table, one compensates with deeper than usual gas anesthesia, in extreme instances ethylene, or very rarely morphine, is used. Both are useful expedients, but neither is ideal. Still, control of a patient in the operating room presents no problem.

#### POSTOPERATIVE

Additional barbituric acid compounds should be used with caution after operation when the need for a postoperative sedative arises, for fear of cumulative toxic action of the drug. When, however, we have grossly underestimated the preparatory dose of luminal calculated to give an uneventful postoperative 24 hours we have occasionally supplemented it with satisfaction as follows. We have given 15 grains every 4 hours when patient was awake until marked effect was secured, placing a definite limit of 5 tablets. On September 19, 1929, a toxic goiter patient, had 18 grains before operation, then 9 more in 6 hours, 27 grains in all, with perfect result. We have never considered this practice unreservedly advisable and, of course, the luminal effect cannot be so nearly perfect as when the entire fitting amount is given *before* operation, though it might be large in some cases.

It must be mentioned that our routine practice is to make use of the analgesic effect of pyramidon compound by administering pyramidon 5 grains every 4 hours until 5 doses are given after operation (the patient having been prepared with luminal), in the attempt to avoid use of morphine for postoperative suffering when present (Gasser). We do not claim that actual acute wound pain is satisfactorily influenced by pyramidon, but numerous aches and other evidences of postoperative discomfort can be relieved to the extent that morphine is infrequently required.

Severe postoperative pain is occasionally experienced by patients who have been adequately prepared with luminal. They require small doses of morphine, though in amount and frequency much less than others not so prepared, the effect of morphine being with them deep and lasting. Here again luminal subjects differ but little from patients enjoying normal sleep in that both are awakened by great pain.

As stated, morphine is used by us for actual postoperative pain, but we strongly incline to other measures for the relief of an uncomfortable position, a desire to sleep, headache, aching bones or joints, heat sensations, gas pains, bladder tenesmus, or nervousness. (Morphine given the patient has often done more good for an overworked interne or for a tired out nurse than for the patient who actually received it. This is said without in the least implying bad faith.)

A highly toxic goiter patient should be given  $\frac{1}{4}$  grain morphine just as soon after operation as extreme restlessness begins, no matter how satisfactory the pre-operative effect of a 30 grain dose of luminal has been, it seems better to add this small amount of morphine if needed after thyroidectomy, thus securing almost immediate relief of symptoms rather than to wait for an almost incredibly large additional dose of luminal to take effect.

A singular postoperative paradox is manifested in a few patients after a large dose of luminal, viz., deep hypnosis interrupted every few seconds or minutes by brief periods of excitation, sometimes maniacal in appearance. These sufferers are easily controlled by doses of morphine so small as to be ineffectual in

the absence of luminal Before giving a second drug we always resort to the restraining sheet, shut out noise and light, while here again employing the soothing touch and voice of a capable nurse This complication is fortunately rare

It is to be noted that a small dose of morphine used after operation does not often cause the nausea and vomiting which seem to characterize its use as part of a combined anæsthesia

#### INTERRUPTION

The duration of luminal hypnosis is markedly shortened and its intensity correspondingly lessened by an intercurrent surgical operation under gas anæsthesia, although the patient has not been awakened during the entire procedure This interesting fact is apparent to one who has in a few instances had to postpone an operation after giving the luminal, and then, a few days later, after the same dose had been given had performed the operation An example follows after taking 15 grains on October 9, 1929, Miss B slept 20 hours Three days later, a cold having cleared up, she was given a like dose and operated on for inguinal hernia 3 hours later She slept for the succeeding 10 hours, that is, for a total of 13 hours as against the 20 hours during which no operation was done This instance is fairly typical of several others which have formed a part of our experience

#### ADVANTAGES

A surgical anæsthesia produced by luminal and nitrous oxide gas (at times ethylene) has impressed us with certain definite advantages

1 There are no harmful pre-operative anticipations, the patient is not cognizant of transportation to the operating room, the sights, odors, and sounds which characterize this room fail to register, her condition closely resembles sound normal sleep, still she will sometimes ask a question and will usually answer one, the situation seems ideal from the standpoint of patient and operator alike, the needle prick for local anæsthesia is immediately forgotten while there is little, if any, sense of suffocation accompanying the first inhalation of a general anæsthetic

2 During the operation a surprisingly small quantity and concentration of gas has been required for complete satisfaction, consequently cyanosis and bleeding are diminished, while hæmostasis assumes a new and unawaited facility

3 After operation one sees practically no sweating and comparatively rarely any nausea The postoperative administration of fluids by mouth has in consequence largely supplanted the hypodermic and intravenous methods to the relief of the nurses and to the patient's delight, if she has ever experienced these methods Her natural tendency to vomiting is lessened, by this luminal method, as stated (Morphine and the other opium derivatives employed for purpose of *induction* have seemed, in the writers' experience, largely responsible for the vomiting occurring during and following anæsthesias of whatever sort in which they play a role)

There is, too, a welcome postoperative oblivion of many hours' duration (56 hours in one instance) It is unusual for the patient to recall any incident from the day of operation, next day she often fails to recognize the day nurse who returns at 7 00 a m, to the latter's great surprise—the patient having seemed moderately oriented, though sleepy, when she left at 7 00 the previous evening

4 An economic phase of the subject becomes apparent when one reflects that a patient who is neither excitable, vomiting, suffering, nor disturbing the neighbors makes a minimum requirement upon the nursing personnel

We are convinced that luminal alone makes the ideal preparatory drug in doses of 12 to 30 grains, given 3 hours before operation, it is rarely vomited, and no "supplementary" is needed as a rule The dose, 12 to 30 grains, has harmed no adult, if one excepts a few transient skin rashes, while 30 grains controlled perfectly the wildest toxic thyroid patient imaginable, who had entered the hospital only 10 days before operation, with basal metabolism rate of  $+122$

We desire to express our appreciation of their suggestions to Professors Gasser and Gruber of the Pharmacology Department, Medical School, Washington University



# CLINICAL SURGERY

FROM THE SURGICAL PEDIATRIC CLINIC, ROYAL UNIVERSITY OF FLORENCE

## URANOSTAPHYLORRHAPHY

SENATOR PROFESSOR GEROLAMO GATTI FLORENCE, ITALY

Director Institute of Surgical Pathology and Surgical Pediatric Clinic Royal University of Florence

THE chief difficulties in uranostaphylorhaphy lie in the production of anaesthesia, the securing of haemostasis, and the suturing of the edges of the fissure in the palate. The dangers and complications to be avoided are, during the operation the inspiration of blood from the wound into the respiratory tract which may cause pneumonia, and, during and after the operation, infection of the wound and failure of the sutures to hold.

The indications for the operation depend primarily upon the age of the patient and the size of the fissure.

As to the age of the subject, while it is my custom to operate on simple harelip and fissure of the alveolar border from the eighth month on, I defer operation for fissure of the palate until the patient is 4 years of age, in order to make the operation easier and to avoid complications. A delay until the patient is 4 years of age does no

harm, for, as the fissure has a certain tendency to contract, it is then decreased rather than increased in size. I do not defer operation too long, however, for it is easier to correct defects of phonation and pronunciation by education if operation is performed at a relatively early age. Furthermore, the results are better if operation is delayed than if done at the early age of 2 to 4 years or the very early age of less than 2 years. Also when the child is 4 or more years of age it is possible to perform the operation in one stage, particularly as the method I use does not consume a very long time.

As to the size of the fissure, the operation can be performed in all cases in which the fissure is not extremely large and in which the lateral flaps are not so small that there is not enough tissue for a plastic operation, it is only in such cases that it is necessary to wear a prosthesis or make an artificial palate.

### PREPARATION FOR OPERATION

The patient is given a purgative or enema and liquid diet the day before the operation. For several days before the operation the nose and mouth are washed with gauze wet with a solution of 2½ per cent potassium chlorate and hydrogen peroxide. At the time of the operation the nose and mouth are thoroughly disinfected with 5 per cent tincture of iodine, the excess being removed after 5 minutes by washing first with 70 per cent alcohol and then with alcohol and ether.

### TECHNIQUE

*Position of the patient.* In order to prevent blood from flowing from the wound into the respiratory tract during the operation, the patient is placed on his back with his head hanging over the edge of the table, that is, in Rose's position, so that the respiratory tract is highest and the vault of the pharynx the most dependent part, thus allowing the blood from the wound to

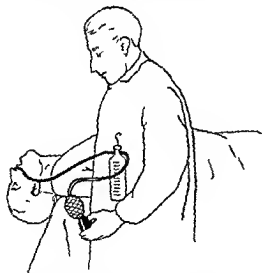


Fig. 1. The Junker apparatus with the rubber tube in the patient's nostril. Patient in Rose's position.

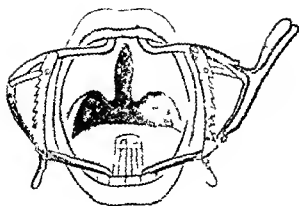


Fig. 2 The Whitehead gag in place

flow into the vault. With the patient thus and with proper hæmostasis, the anæsthetic may be given without danger of blood flowing into the respiratory tract. The operator sits so that his knees are beneath the hanging head of the patient.

**Anæsthesia** The Esmarch's mask covered with sterilized gauze is used to start the anæsthesia. After the patient has been put to sleep I have this mask removed and, in order to continue the anæsthesia during the operation without encroaching on the field of operation, I use a Junker apparatus, the rubber tube being kept in the nostril during the operation. As is usual in early childhood, the amount of chloroform used is reduced to a minimum that is strictly necessary. In later childhood I use ether (Fig. 1).

**Keeping the mouth open** One important point is that the mouth be kept wide open during the whole operation. This should be accomplished by some means other than having an assistant hold a gag in the patient's mouth, particularly as the assistant's hands would encumber the field of operation, and also if the patient is not well anesthetized, the hand gag does not stay in place but moves about allowing the mouth to close, thus interfering with the movements of the operator. I therefore use Whitehead's gag. This keeps the mouth wide open and it is not necessary for an assistant to hold the gag, the field of operation is not encumbered and the spatula of the Whitehead gag keeps the tongue depressed without the aid of an assistant, and the necessity of tongue forceps is eliminated (Fig. 2).



Fig. 3 Sponge holder with sponge

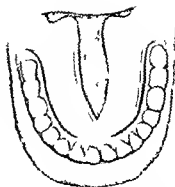


Fig. 4 Liberating incisions

**Hæmostasis** Hæmostasis is accomplished by means of gauze sponges mounted on a sponge-holder with a long handle. This holder is manipulated by an assistant. If it happens that quite a large amount of blood accumulates in the pharynx, a forceps holding a sponge may be introduced into the pharynx one or more times and turned around so as to absorb all the blood and dry the cavity. In my clinic to keep the blood out of the operating field, I also use an aspirating pump which is run by an electric motor.

**Freshening of the edges of the wound and detachment of a fibromucous flap from the bone of the palate** The two edges of the fissure in the palate are freshened with a small bistoury. I then make two linear incisions, liberating incisions, near the two alveolar borders and parallel to them, they extend down to the bone and from the canine tooth to the posterior border of the bony palate (Fig. 4).

To detach the fibromucous flap from the bone of the palate I use a "periosteum detacher," with a posterior bend which I devised and had made especially to make this detachment easy and rapid. The periosteum detacher is introduced into the incision and the fibromucous flap is detached from the bone to the fissure, thus creating two flaps which can be moved toward the midline and brought together without tension (Figs. 5 and 6).

**Suture of the edges** After these two flaps have been made the edges of the fissure are sutured, the two bridge flaps which have been detached



Fig. 5 Periosteum detacher with a posterior angle

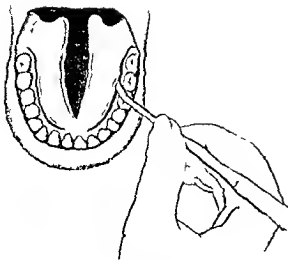


Fig. 6 Periosteum detacher in use



Fig. 7 The Reverdin needle with right angled holder

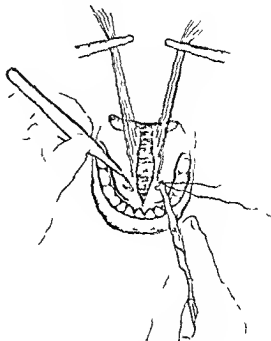


Fig. 8 The Reverdin needle in use

being moved to the midline. As it is hard, even with a small needle with the usual curve, to apply sutures in the small mouth of a child and as it is a slow process because the needle has to be passed through one edge and then removed and reinserted in the needle holder before passing through the other edge I use Reverdin's needle with a movable eye attached at right angles to the holder (Figs. 7 and 8).

As this needle has only a slight curve it can easily be threaded with silk and passed through both edges of the fissure. The silk suture is caught with toothed forceps, the eye of the needle opened, and the needle removed without the thread. The two long ends of the thread are then caught and held with a Pean's forceps. The other sutures are then put in, but are not tied until after they are all in place. Enough tissue must be caught on each side that sutures will hold.

The two liberating incisions along the alveolar borders remain open and are even widened by the two flaps being brought together in the midline, but as the bone lies beneath them that does not make any difference for they soon fill with granulations. The suture line is washed with alcohol and the gag removed.

#### POSTOPERATIVE TREATMENT

The patient is isolated in a room that is dimly lighted and no one admitted except those who have to take care of him. This is so that he will be as quiet as possible and not talk or eat. For the first 3 days after the operation he is not given any food by mouth. Nutrition and blood pressure are kept up by proctoclysis and rectal nutrient enemas. After 3 days he may be given water and coffee with milk by mouth, through a rubber tube. The mouth is cleaned every day with sponges wet with boric acid solution, and the suture line is bathed with 50 per cent alcohol. The sutures are removed in two stages, the first ones in 10 days and the rest in 12 to 15 days. Soon after this, education in phonation and pronunciation is begun.

#### RESULTS

With this method the results have been good in all cases, there have been no deaths and the plastic results have been good. As to education in phonetics, phonation, and pronunciation if this has been carried out diligently over a long period of time, great improvement has resulted in the majority of cases, particularly when the child begins to understand how essential it is that he learn to speak correctly, and he works intelligently himself.

## FROM THE LAHEY CLINIC

## THE SURGICAL MANAGEMENT OF PHARYNGO-ŒSOPHAGEAL DIVERTICULUM

BASED UPON AN OPERATIVE EXPERIENCE WITH TWENTY-ONE CASES<sup>1</sup>

FRANK H. LAHEY, M.D. F.A.C.S., BOSTON

THE earliest report of a case of œsophageal diverticulum found in the literature was made by Mr Ludlow, surgeon of Bristol, England, in 1767, in *Medical Observations and Inquiries*, under the title of "A Case of Obstructed Deglutition from a Præternatural Dilatation of, and Bag Formed in, the Pharynx." The specimen recovered at autopsy was prepared and preserved in the Hunterian Museum. During the eighteenth century six further references to similar lesions appeared in the literature, from Italy and Germany. In 1816, in the volume of *Surgical Observations*, Sir Charles Bell published a paper entitled "A Præternatural Bag Formed by the Membrane of the Pharynx." In this article appeared an illustration showing a bag defined in the text as a protrusion of the inner coat of the pharynx through the fasciculi of the constrictor pharyngis. Medical literature throughout the nineteenth century contains a good many references to this subject, but it remained for Zenker and von Ziemssen in *Krankheiten des Oesophagus* in 1877 to clear up the confusion and discussion as to the etiology and symptomatology of the condition. These authors made a careful study of the literature, which included 23 cases previously reported, and added 5 cases of their own, all of which came to autopsy. From the postmortem examinations, they verified the classification of traction and pulsion diverticula, and one of these terms is now commonly used in describing such neoplasms.

Rokitansky in 1840 first correctly described traction diverticula as produced by outside traction on the œsophagus usually from the cicatrix of a previously inflamed lymph node. These diverticula have a characteristic funnel shape. They may occur at any age, even in childhood. They rarely cause symptoms during life because the end of the sac is usually directed upward or horizontally forward rather than downward, and because the muscle layer is usually involved and by its contraction keeps the pouch empty. The site of the traction diverticulum is always in the œsophagus itself, usually on the anterior wall and most commonly at the bifurcation of the trachea.

Pulsion diverticula, on the other hand, have been shown to be of entirely different origin. They are located on the posterolateral wall of the pharynx just above its junction with the œsophagus. They project from between the fibers of the inferior constrictor between the transverse and oblique bundles of the cricopharyngeal division of that muscle. The pouch of the diverticulum is located in the prevertebral space behind and usually to the left of the œsophagus between the layers of the prevertebral and pretracheal fasciæ. The shape of the pouch is sometimes that of the finger of a glove. The small diverticulum tends to be spherical and the

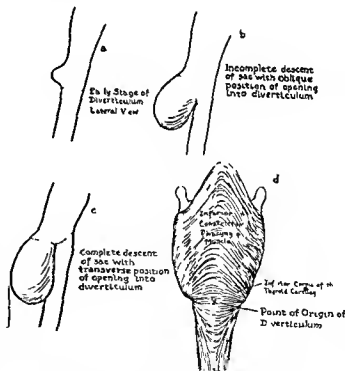


Fig 1 Illustration showing diagrammatically the different stages of diverticula. Early, A, intermediate B, late, C, and the point on the posterior wall of the pharynx between the fibers of the cricopharyngeal muscles through which the sac emerges (pharyngeal dimple), D. This drawing illustrates diagrammatically the relative change in the position of the true opening into the œsophagus and the opening into the diverticulum in the early, A, intermediate, B, and late diverticula, C.

<sup>1</sup>Read before the Southern Surgical Association, Atlanta, Georgia, December 21, 1929.



Fig. 2

Fig. 3

Fig. 4

Fig. 2 Showing the smallest type of esophageal pulsion diverticulum. This type does not lend itself to two stage operation as described in the text as it is too small to implant in the wound. In this type it is better to delay operation until it has increased in size.

Fig. 3 The typical medium sized pharyngeal esophag-

cal diverticulum. This size will just about implant in the wound with the dome up to or barely above the skin level.

Fig. 4 A more or less glove finger shaped pharyngeal esophageal diverticulum. This type is sufficiently long readily to implant in the wound with the dome well above the skin level. It is the easiest type upon which to perform operation.

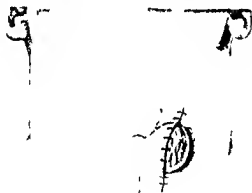


Fig. 5 Showing the principle of two stage removal of esophageal diverticula. The sac has been completely dissected from its bed in the superior mediastinum when large or from behind the esophagus when small and implanted in the incision in the neck.

Note that as discussed in the text, the lower angle of the neck of the sac has been completely dissected from the longitudinal esophagus and also that the sac has been so implanted in the wound that there is no angularity of the esophagus.

larger ones pear shaped. The opening into the sac is large in proportion to the size of the pouch.

Esophageal diverticula are more common in men, the ratio being about four to one. It is a condition of middle or advanced age.

Iudlow believed that the etiology of this condition was traumatic and due in his case to the swallowing of a cherry stone. Sir Charles Bell in 1816 stated that he believed the condition to be due to distention of the pharynx from ineffectual attempts to swallow, thus causing a protrusion of the inner coat of the pharynx through the bundles of the inferior constrictor pharyngis. This theory—that the diverticulum is a protrusion of the mucosa through the musculature of the pharynx due to abnormal intrapharyngeal pressure, plus localized weakness at the so called pharyngeal dimple is still acceptable today. The pharyngeal dimple is the central point in the posterior wall of the pharynx between oblique fibers of the cricopharyngeus where that muscle splits off from the inferior constrictor to become longitudinal (Fig 1D).

The symptoms of esophageal diverticulum, as described by Hugo Starck in 1900, are prodromal direct, and indirect. Prodromal symptoms consist of expectoration of mucus clear or purulent, dryness, and a scratchy feeling in the throat,

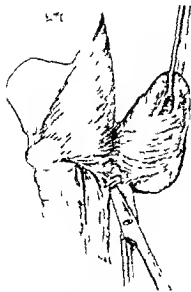


Fig 6

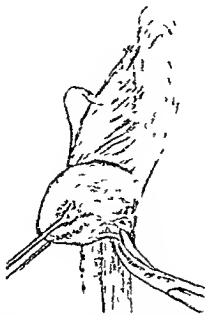


Fig 7

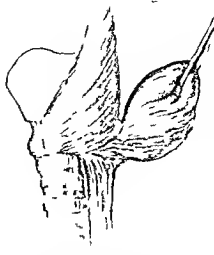


Fig 8

Fig 6 Showing diagrammatically the separation of the adhesions and fibers of the cricopharyngei muscles from the neck of the sac and the longitudinal œsophagus in order to overcome the angulation which occurs here as described in the text

Fig 7 Showing diagrammatically the sac pulled to the side upon which the skin incision has been made (left) and the adhesions and fibers of the cricopharyngei on the right

between the neck of the sac and the longitudinal œsophagus being separated to make complete delivery of the sac possible

Fig 8 Showing diagrammatically the neck of the sac completely freed of its attachments to the longitudinal œsophagus and ready for implantation in the wound. Note the change in angles in the lower and upper points where the diverticulum joins the œsophagus

salvation, a choking sensation, at times a feeling of a foreign body in the throat, and at times a fear of swallowing because of the feeling that food may stick in the throat. These are the symptoms which are associated with a very small diverticulum, an example of which is shown in Figure 2

As soon as the sac attains sufficient size (Figs 3 and 4), direct symptoms appear. These include the inability to swallow large particles of food at first, then smaller particles, then semi solids, and finally, in the extreme cases, patients are unable to swallow even fluids. The obstruction is due at first to pressure of the sac, filled with food, on the œsophagus to which it lies parallel. The final obstruction is largely due to the fact that the diverticular opening in the œsophagus is so dragged down by traction on the sac that it is no longer lateral, but transverse, and the direct opening into the œsophagus becomes a lateral slit-like orifice (Fig 1, a, b, c)

Regurgitation is always present, occurring usually during or after meals. It is frequently spontaneous, but is often accomplished by finger pressure over the sac or by the assumption of certain postures. Regurgitated material is made up of food from a former meal mixed with mucus

and may or may not be putrefied. It differs from vomitus in that it contains no hydrochloric acid

Gurgling noises in the throat frequently appear due to the mixture of air and food within the sac

Sometimes as a result of the pressure from a large sac distended with foods, hoarseness occurs

X ray examination of the sac filled with bismuth shows the diverticulum to be spherical or pear-shaped with a definite, flat fluid level readily demonstrated (Fig 3)

The treatment of œsophageal pulsion diverticulum other than dilatation, which gives only temporary relief, is surgical, and in an operative experience dealing with 21 of these cases, we have had an opportunity to become acquainted with some of the commonly accepted measures as well as with some of the things which should not be done in operating on these patients

Mention is made of the number of cases operated upon (1) to prove the relative safety of the operation, and (2) to demonstrate that we have operated upon a sufficient number of these patients to have encountered most of the mistakes and difficulties that may present themselves during operation and to have developed procedures to overcome them. This paper is written with the hope that a discussion of these difficulties and the

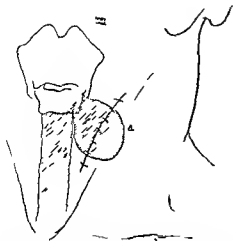


Fig 9 Showing diagrammatically the acute angulation at point where neck of diverticulum joins the esophagus inferiorly when sac is not completely dissected and implanted high. Showing also the tendency of food to pass into the sac before its removal, or the sinus after its removal.

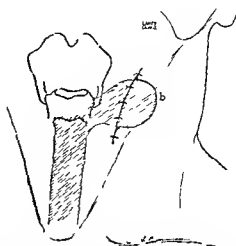


Fig 10 Showing diagrammatically how complete dissection of the neck of the sac and high implantation overcomes the acute angulation and the tendency of food to enter and accumulate in the sac.

procedures we have developed to overcome them may be of service in preventing others from making similar errors.

The average age incidence in our series is 67. The specific ages are as follows: 42, 43, 46, 46, 48, 49, 52, 54, 55, 55, 59, 60, 60, 61, 62, 68, 70, 70, 72, 76, and 80.

All patients were operated upon by the two stage procedure. In a majority of the cases local anesthesia was used and today cervical block is used in all cases unless, as occasionally happens, the patient demands a general anesthetic, in which case ethylene is employed. All patients are swallowing quite well. Two require the occasional passage of olive tipped esophageal bougies. There has been no mortality.

As the result of our experience with these cases we feel that the two stage operation is now so safe and the second stage so easy to do and productive of so little discomfort to the patient, that we have no interest in any one stage plan of removing such diverticula. Based on our experience we feel that should a patient die, after removal of an esophageal diverticulum in one stage such a fatality would probably not have occurred had the operation been done by the two stage method.

The general plan of the two stage removal of esophageal diverticula consisting of the complete dissection of the sac and its implantation in the wound as the first step and the removal of the sac at a second stage 10 to 12 days later when the fascial planes in the neck have become occluded, is very well understood (Fig 3), but experience

with the operation has led us to develop procedures which, in our hands, have diminished the immediate complications and have improved the remote results of the operation.

One of the fundamentally essential features of the operation is that an adequate exposure be had of the neck of the sac and also of that portion which descends into the mediastinum. To accomplish this we have made our incisions extend from the level of the cricoid cartilage in front of the sternomastoid muscle well down to the region of the clavicle. In all of our operations we have approached the diverticulum by incisions on the left side of the neck. The incision is deepened until the internal jugular vein is exposed at which point the middle thyroid veins running from the internal jugular to the thyroid glands are ligated. With these tied, the incision can be deepened to the common carotid artery, behind which is found the inferior thyroid artery, which is caught between clamps, cut and both ends ligated. We have usually cut the omohyoid muscle at its tendinous portion and have turned the anterior belly forward. This step is not always necessary, although it is our belief that a better exposure of the neck of the sac may be obtained when this is done.

With the inferior thyroid artery cut and ligated it is now possible to turn the entire lobe of the thyroid gland forward so that the lateral wall of the esophagus and the side of the diverticulum when it is small, or its top, when it is large and intrathoracic, is plainly visible.

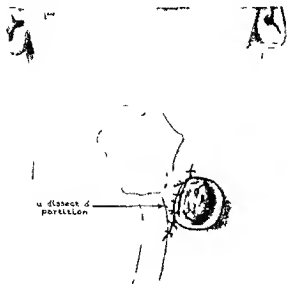


Fig. 11 Showing a combination of two mistakes which cause postoperative difficulties. Because the neck of the sac has not been completely dissected at its inferior angle and on its right side, where the diverticulum joins the esophagus, a high implantation of the sac on the skin has pulled the esophagus to one side and angulated it. As stated in the text, these two technical errors direct food into the sac, the sac becomes distended, and in some instances necrotic. After the sac has been removed this partition directs food along the sinus and keeps it open (Compare with Figure 7)

The sac is grasped with blunt edged tenaculum forceps of the Babcock type and is gently dissected from its bed behind the esophagus or in the superior mediastinum.

There are two points here with which, in our early cases, we had difficulty, and concerning which I wish to speak. First, it is most important that all of the adhesions of the sac to the longitudinal wall of the esophagus (Fig. 6) in back and on the opposite side behind the esophagus be most carefully and most painstakingly freed. This involves gentle upward traction of the sac, good exposure by means of long bladed retractors placed behind the longitudinal esophagus, and very careful dissection of all adhesions and cricopharyngeal muscle fibers until the entire sac of the diverticulum rolls out so freely that by traction on the sac the esophagus can be so rotated that the right side of the neck of the sac can be visualized, demonstrated, and completely freed (Fig. 7). If this step in the operation is not carried out, it will not be possible so to implant the sac in the wound that complete removal of its mucous membrane lining will be possible at the second stage procedure. Incomplete separation of adhesions between the neck of the sac and the



Fig. 12 Showing the proper position of the sac after the wound had been reopened, the sac implanted at its proper level on the skin, and the esophagus replaced in its proper median position. Showing also the catheter passed through the diverticulum down the esophagus into the stomach and sutured by purse string suture into the dome of the diverticulum when immediate feeding is necessary. Note that the proper dissection of the lower angle of the diverticulum and esophagus is diagrammatically shown.

right side of the esophagus prevents adequate and entire delivery of the sac (Fig. 8).

The second point we have learned, and failure to appreciate which resulted in some undesirable complications in our first cases, is that it is necessary so completely to dissect the neck of the sac of the diverticulum up to the point where it joins the esophagus that its angular relationship with that structure is exactly reversed. In Figure 9 we find that the undisturbed relationship between the neck of the diverticulum and the longitudinal wall of the esophagus is such that the two walls will be practically parallel, forming between them the sharpest form of an acute angle. Again looking at the same illustration and observing the relationship of the upper wall of the neck of the diverticulum, we find here almost the widest possible form of an obtuse angle. So completely must the dissection of the inferior and lateral walls of the neck and walls of the diverticular sac be made that it can be turned upward so as to cause the inferior acute angle (Fig. 9) to become an obtuse angle (Fig. 10) and the superior obtuse angle (Fig. 9) to become an acute angle (Fig. 10). If care is not taken to make this dissection carefully and completely up to the neck of the sac before the dissected sac is implanted in the wound, swallowed food will still tend to enter the sac because of this undissected partition (Figs. 9 and 11) and, as has twice happened in our experience, the accumulation of food within



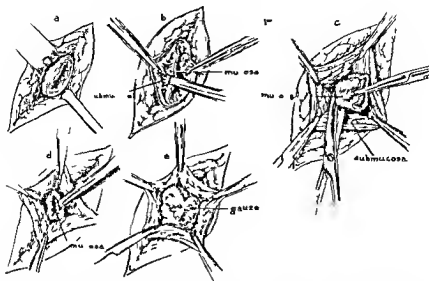


Fig. 13. Showing the wound opened. A The portion of the sac implanted on the skin cut off. B the mucosa separating from submucosa. C the separated mucosa pulled out and being cut away. D the denuded submucosa free in the wound. E the remnant of mucosa in the neck of the sac has been freed from the submucosa and pushed down into the wound and the canal made by the denuded submucosa is packed with boric ointment gauze to prevent leakage.

the sac so distends its walls that necrosis of the sac results, requiring its premature opening. A further disadvantage of leaving part of the in-

ferior wall of the sac adherent and undissected from the longitudinal wall of the oesophagus is that such a partition at this point tends to catch food and guide it outward along the operative sinus rather than to direct it downward along its natural and proper course. This results in food being discharged through the side of the neck for a long time after operation, and also closure of the sinus following the removal of the mucous membrane at the second stage procedure is delayed.

With the lower angle of the sac completely freed, as described, it becomes possible so to implant the sac in the wound that the body of the sac is a little higher than the neck of the sac thus maintaining the obtuse angle at the point where the neck of the sac joins the oesophagus inferiorly and preventing food from passing out into the sac and distending it (Figs. 5, 10, 12) as already mentioned. We have described this step in a previous discussion of this subject, and we believe that it is an extremely important point.

One must use care in the implantation of a large diverticular sac into the wound that the sac is not pulled too far out into the wound, thus so angulating the oesophagus that obstruction occurs (Fig. 11). With the wound open and the sac exposed, the implantation must be tested so that a point is found on the wall of the sac to which the skin can be attached without distorting and dis-

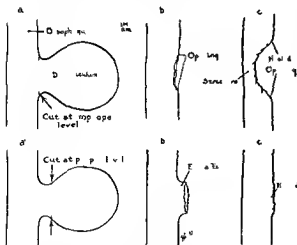


Fig. 14. Showing diagrammatically in A the improper level down to which the mucosa of the neck of the sac is freed and cut off. In B the type of defect in the lateral wall of the oesophagus which will result from cutting the mucosa off flush with the longitudinal wall of the oesophagus. and in C a diagrammatically exaggerated narrowing after healing (with out suture). A represents the proper level at which mucosa should be cut off. B the excess of mucosa to prevent narrowing after healing. and C healing with the extra cuff and without narrowing.

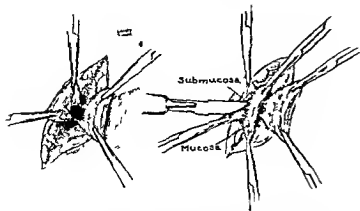


Fig 15 Showing a method of separating and splitting the entire thickness of the implanted portion of the sac at its upper and lowermost points so that the implanted portion of the sac is converted into two flaps from which the mucosa can then be readily visualized and separated from submucosa down to within half an inch of the longitudinal œsophagus as described in the text. Separation of the mucosa from the submucosa saves difficulties with the internal jugular and common carotid

locating the œsophagus from its natural median position

We have in our early experience twice been too anxious to obtain too complete implantations of large sacs upon the skin, with the result that we found our patients unable to swallow even liquids on going back to bed. In these cases we reopened the wounds on the second and third days, replaced the œsophagus in its normal median position, and resutured the sacs in the wounds at proper levels. In both of these cases we opened the apex of the sacs, as they were implanted in the skin after correcting the œsophageal angulation, and inserted catheters down the œsophagus into the stomach in order to be certain that the patients would receive food and fluids. The catheters were held in by purse-string sutures and care was taken to wall off carefully the surrounding skin and wound while the sacs were being opened (Fig 12)

This is a valuable measure to bear in mind, we believe, and can well be employed in any case in which there is difficulty in swallowing after the first stage operation

Dissections of the neck of the diverticular sac must be done with great gentleness and care, as, in one's enthusiasm for a complete separation of the two structures, it would be very easy to carry the dissection through the wall of the neck of the diverticulum and thus produce leakage, soiling, and a possible serious cellulitis. We have never had the misfortune to open the sac of an œsophageal diverticulum during its dissection, but we do realize how easily and unknowingly it could be done

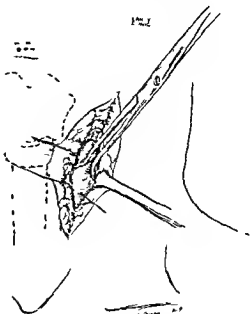


Fig 16 Showing diagrammatically a sac which has retracted into the wound at the second stage operation. Unfortunately, they are not all as readily demonstrated as this when they have retracted from their skin implantation into the wound

In our experiences, we have learned that it is easiest to operate on patients with large diverticula. While the removal of large diverticular sacs from the mediastinum is often difficult and demands great technical skill, the size of the sac readily permits of its being so implanted in the wound that the dome of the sac projects well above the level of the skin, and in spite of the shrinkage and retraction of the sac into the wound, which occurs in all cases in the interval between the first and second stages of the operation, the dome of the sac still projects well above the skin level when the second stage of the operation is done, so that second stage procedures under such conditions are extremely simple. The dome of the diverticular sac may be cut off just above the level of the skin. With tacking forceps the mucous membrane lining of the sac may be grasped and by blunt dissection with scissors, because of the œdema and thickening, easily separated from the submucosa with very little bleeding down to the point where the mucous membrane lining the sac joins the mucous membrane lining the longitudinal œsophagus (Fig 13, a, b, c, d)

It is important in removing the mucous membrane that all of it is not removed exactly to the point where the mucous membrane of the diverticular sac joins that of the longitudinal œsophagus (Fig 14 a). If too much mucous membrane is removed, as will be seen by Figure 14 b,

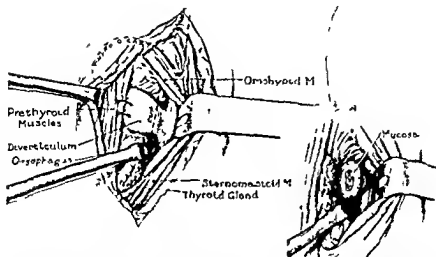


Fig 17 Showing a diverticular sac too small to reach the skin implanted in the wound and anchored at its dome to the outer border of the prethyroid muscles to facilitate its demonstration and re isolation at the second stage operation. On the neck of the sac the dotted lines represent the level at which the layers of the sac are cut across at the second stage and the insert shows this done without disturbing the neck of the sac. In the insert one sees the mucosa and submucosa at the second stage ready for separation as shown in the next illustration.

closure of the hole in the posterior wall of the oesophagus, which represents the opening into the diverticular sac can be accomplished only by cicatricial contracture and so (Fig 14 c) will result in narrowing of the oesophagus.

We had such an experience in some of our cases and in these patients it is necessary occasionally to pass bougies.

We have suggested and now practice the plan, at the second stage of the operation of passing the finger down the sac of the diverticulum with its top cut off until the finger tip just reaches through the opening into the longitudinal canal. With the finger in this position the length of the wall of the diverticular sac can be measured on the examining finger and the finger withdrawn for about a half an inch to allow for a cuff of mucous membrane to be left at the neck of the sac (Fig 14 a). An amount of the mucous membrane which has been separated down to the neck of the sac and which will correspond with the measured length of the sac less one half inch which has been allowed for a cuff of mucous membrane at the neck of the sac can then be removed (Fig 14).

If any difficulty is encountered in separating the mucous membrane from its underlying submucosa, the wound can be opened above and below the implanted sac, the entire thickness of the sac readily separated from its implantation in skin, subcutaneous fat and muscle, and an incision can be made with scissors at the lowest and uppermost portions of the sac through all layers from the level of the skin down to within one half inch of the neck of the sac. This converts the sac into two flaps as shown in illustration (Fig 15) and permits of removal of the mucous membrane or all layers of the sac down to the point one half inch from the oesophagus itself. Preservation of the layer of submucosa and separation of the mucosa from it particularly on the outer side prevents injury to the internal jugular vein and common carotid artery at the second stage operation.

The first stage removal of small oesophageal diverticular sacs is much easier than the removal of the large intrathoracic ones, but the management of small sacs which do not reach to and remain above the skin level when implanted into

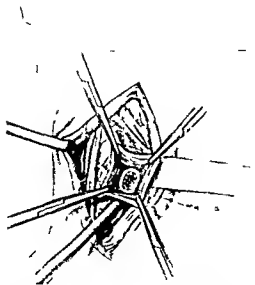


Fig 18 The submucosa is shown grasped by hemostats and the mucosa separated and cut off deep in the canal made by the remaining submucosa. This mucosa is shown pushed into the opening in the œsophagus at the neck of the diverticulum in the following diagrammatic illustration (Fig 19). Note that this makes the dissection of the mucosa from the underlying structures within a canal of submucosa.

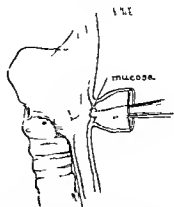


Fig 19 Showing diagrammatically the mucous membrane dissected from the submucosa, cut off, and pushed down into the diverticular opening into the œsophagus, and the canal of submucosa from which the mucous membrane has been separated, which is to be packed with boric ointment or vaseline gauze.

the wound is not by any means so easy. All sacs which at the time of implantation in the wound, that is at the first stage operation, reach only to or just above the level of the wound, will, as the result of œdema and thickening, retract into the wound below the level of the skin at the end of 10 to 12 days (Fig 16), when the second stage procedure is contemplated. Many sacs will be found which are so small that they do not reach even to the level of the skin when implanted in the wound.

While large sacs are easy to remove at second stage operations, it is not desirable to delay removal and to subject patients to the constant annoyance caused by the presence of small sacs while they are attaining sufficient size to make it possible to implant them on the skin. Further more, it is desirable to remove the sacs of œsophageal diverticula before they have descended deeply into the mediastinum, thus necessitating the opening and exposure of that cavity to the danger of infection. It is likewise quite as desirable to remove small sacs as large sacs by two stage procedures in order to avoid the dangers of cellulitis and mediastinitis.

It must be realized, however, we believe, that there are diverticular sacs so small that they do not lend themselves to two stage procedures (Fig 2), and one must wait, in such cases, until the sacs have reached such size as to permit of dis-

section, anchoring in the wound and second stage management.

In small sacs, of the size of the diverticulum shown for example in Figure 3, after the completion of the dissection of the sac, we have anchored the top of the sac to the prethyroid muscles, as shown in Figure 17 making no attempt to bring the sac up to the skin.

The fixation of the neck of the sac to this point makes it easy to find the sac when the wound is reopened at the second stage operation, and likewise prevents the retraction of the sac into the space behind the œsophagus from which it was removed. When the sac is not fixed at this point, due to the fact that all tissues in a reopened wound appear much the same, it is not easy immediately to locate the diverticulum implanted in the wound. With the plan outlined, however, the sac can be very readily found by the easy demonstration of the upper and outer fibers of the sternohyoid muscle to which the sac has been sutured. Care should be taken that the sutures which fix the sac to the muscle do not penetrate all the walls of the sac and produce leakage, but pass only through the outer walls of the sac.

The second stage removal of all of the walls of small diverticular sacs has caused us some uneasiness because of the fact that it is necessary, in the removal of the walls of these small sacs, to reopen into the space behind the œsophagus from which the diverticulum has been removed, necessitating packing this space, and, in our opinion, producing at least a slight danger of cellulitis and mediastinitis. To overcome this danger, we have employed the following scheme.

The small sac is detached at the second stage operation from its attachment to the sternohyoid

muscle, and the top of the sac is cut off with scissors, at the dotted line in Figure 17 and as shown in the insert in Figure 17. This exposes the submucosa of the sac, which can be grasped as in the second stage removals of the large sacs, and the mucous membrane can be separated from the thickened and oedematous wall well down to the point where the sac joins the œsophagus (Fig 18). The openings in the small sacs are so small that there is no danger, as in the large openings of the large sacs, from narrowing of the œsophagus with cicatrization of the defect in its wall. With the mucous membrane removed from the sac, the excess of sac wall can be cut away, care being taken not to open the cavity behind the œsophagus from which the sac was removed at the first operation, and which is now well walled off by organizing exudate. With the excess of sac wall cut away, a small strip of boric ointment impregnated gauze is passed down into the sac canal pushing any loose mucous membrane ahead of it into the œsophagus, as the wound is closed about the drain. When the mucous membrane has been freed and pushed into the œsophagus this way (Fig 19), with boric ointment gauze, there has been but very little secondary leakage of food and fluids following the second stage removal of the sac. This is particularly true if the dissection of the sac has been carefully carried out about the neck of the sac as described earlier in the paper.

In the beginning of our experience with the two stage removal of œsophageal diverticula, drain

age of food and fluids through the side of the neck occurred for a considerable time, often 3, 4, and 5 weeks, but since we have learned to make complete dissections of the neck of the sacs, to separate mucous membrane from the thickened wall of the sac, and in large sacs to implant the sacs in the wound at a slightly higher level than the neck of the sac we have had no difficulty with prolonged leakage through the wound in the neck and closure has frequently taken place within 10 days.

#### CONCLUSIONS

The two stage operation for œsophageal diverticulum is a safe one.

Proper dissection of the neck of the sac and high implantation of the sac overcomes many of the postoperative difficulties of the operation.

A plan is presented for the implantation of small diverticula within the wound, and also one for the excision of the mucous membrane lining the small implanted sacs without reopening the space just in front of the prevertebral fascia.

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## THE SIGNIFICANCE OF RENAL COUNTERBALANCE IN RENAL SURGERY

WITH REFERENCE PARTICULARLY TO THE REPLACEMENT OF UNILATERAL AND BILATERAL HYDRO-ANGULAR URETERS AND HYDRONEPHROSIS, WITH A DESCRIPTION OF AN OPERATION FOR THIS CONDITION

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CONSERVATION of renal tissue is the objective of modern renal surgery. Experimental work demonstrates an ability of repair sometimes most remarkable, findings that are being widely confirmed by clinical experience. The growing interest and success in the surgical repair of ureteral and ureteropelvic conditions of obstruction is good evidence of this. The relatively small amount of functioning renal tissue necessary to maintain health is being more and more appreciated, and many patients with advanced renal insufficiency who formerly were pronounced incurable, are now given the benefit of surgery with recovery of sufficiency. One can remove eventually as much as 75 per cent of the total renal mass and the animal will live in good health. In other words, given the equivalent of

four kidneys, any one is capable of growth and an increase of activity for all if three are removed separately at sufficient intervals for the gradual optimum stimulation of the remaining portion. The compensation is effected by an hypertrophy of secretory units. Each does more work more continuously than before so that in the end the total work done is the same.

In the enthusiasm of conservation, certain factors that control compensatory hypertrophy are very apt to be overlooked. Of two kidneys, one alone may be injured and the compensatory hypertrophy of the opposite side will be proportional to the extent of the injury. When diffuse or total on one side, the opposite gets maximum stimulation. Often injuries are localized or circumscribed, and then the uninjured units of the injured side

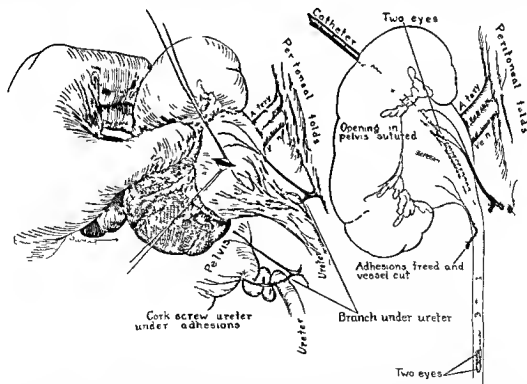


Fig 1 (D.H., No 3603) Drawing to illustrate the method of nephrostomy and placing of nephrostomy tube so as to splint the upper ureter after it has been straightened. This case also illustrates the angularity developing above the point of obstruction in the upper ureter the obstruction being due to a small aberrant vessel. At operation the vessel was divided and the ureter straightened and freed of its adhesions and held in its straight position by a nephrostomy splint as illustrated. Postoperative results excellent.

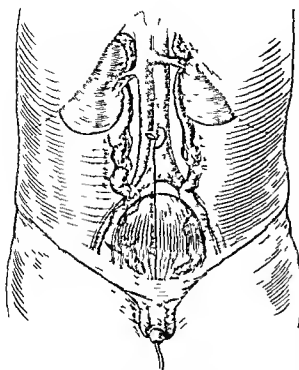


Fig. 2 Diagram to illustrate the line of incision for lateral exposure of the lower ureters extraperitoneally

are stimulated equally with the total units of the opposite side the maximum stimulation of which is diminished by their relative ability and num

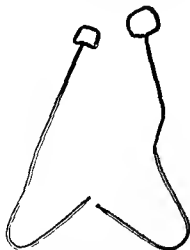


Fig. 3

Fig. 3 Photograph of nephrostomy probes which are passed retrograde through a small opening in the pelvis in order to find the most satisfactory point for nephrostomy opening in a calyx at the thin portion of the parenchyma. The blunt end is forced through, the capsule cut, and a

ber It is estimated that the human adult has anywhere from 2,000,000 to 7,500,000 renal units (Trout) (Among experimental animals,—the dog 1 million, the cat, 400,000, the rabbit, 250,000, the white rat, 75,000, and the frog 2,000) The number varies with the size of the individual, and the greater the number the larger the kidney. If 50 million are removed of a 200 million total the remaining 150 million will hypertrophy enough to carry on total function. If 100 million are eliminated the remaining million carry on efficiently (as after nephrectomy), and even when 150 million units are lost, as with bilateral injury, under certain conditions the remaining 50 million will so hypertrophy as to perform the required work. Maximum hypertrophy requires a gradually increasing and constant stimulation. This may be beautifully illustrated by a 30 day period of complete ureteral obstruction in the dog. If the obstruction is removed at the end of this period and the opposite kidney is removed at the same time, the animal dies of renal insufficiency. If the obstruction is removed and the opposite kidney is left undisturbed, there is a minimum degree of repair which is apt in the course of time to be lost and in one to two years a complete atrophy result. But if the 30 day obstruction is removed and the opposite kidney is handicapped by a partial obstruction of its ureter, which leads to its gradual

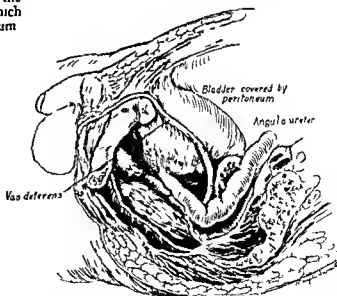


Fig. 4

catheter lead to the grooved end and drawn down through the pelvic opening. The catheter can then be subsequently threaded on down the straightened ureter and the opening in the pelvis closed as shown in Figure 1.

Fig. 4 Relation of lower ureter to vas deferens

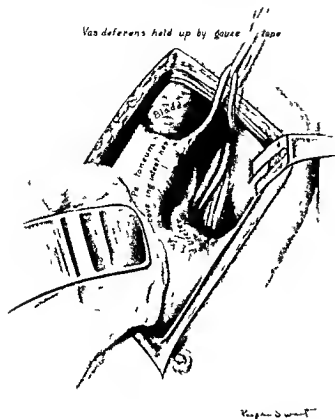


Fig 5 Extraperitoneal exposure of right side of bladder and ureter

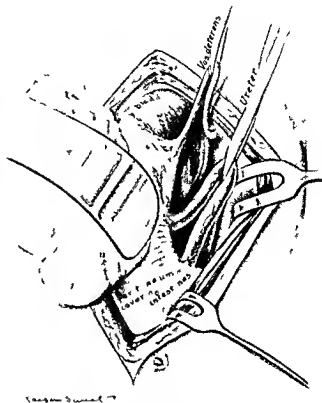


Fig 6 Angulo ureter located and freed at pelvic brim or just above

destruction by complete hydronephrotic atrophy in one to two years, the repair kidney will have undergone, in this time, a maximum degree of hypertrophy easily capable of total renal work. In other words, renal repair is not only proportional to the ability of repair (extent and character of the injury), but to the character and permanency of the demand for repair. The repair in the presence of bilateral injury will be more successful and greater than of the same degree of unilateral injury, provided the injury is of size, because of the greater and more persistent demand. In a slight and early injury, even if bilateral, there will be little difference because either side is still capable of marked hypertrophic changes and, if unilateral, many healthy hypertrophic units still persist in the injured side. But if the injury is marked, bilateral repair will be maximum because it is needed, whereas in a unilateral advanced injury the opposite uninjured side has undergone a certain compensatory hypertrophy which diminishes by so much the need and demand of repair of the injured side.

These statements are all relative to the degree of success of the repair procedure and to the course of the secondary infections almost invariably present. Persistence of pyelonephritis

after removal of an ureteral obstruction will handicap and delay hypertrophic changes in that kidney, just as will partial relief of the obstruction by unsuccessful surgery. Ten years ago I did a two stage plastic repair for a bilateral hydronephrosis of size, the total function being 10 per cent. Total function quickly rose to around forty-five per cent, where it has remained, but pyuria persisted with periodic exacerbation and pyrexia. Relative studies have shown a gradual loss of the earlier repair on one side, the last functional test showing only 2 to 3 per cent compared to an earlier 15 per cent. There has been no redevelopment of pelvic dilatation as before operation, but the kidney has wasted away. Two years ago I removed it and it exemplifies an atrophic pyelonephritis. There have been no further exacerbations of infection with pyrexia. The urine has remained clear. Total function remains at forty-five per cent. In an unilateral condition the factors mentioned for and against success are more active. Attempt to repair any infected unilateral hydronephrosis of size is unjustifiable if the opposite side is normal. The chances of success are too small and the degree of repair secured, if successful, insignificant. Unless reasonably sure that at least half a kidney (50 million units) will be saved



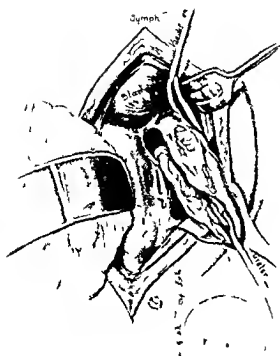


Fig 7 The angular hydro ureter has been drawn below the vas deferens. The lower kinks and angulations have not been freed of peritoneal adhesions. When so freed the ureters show very much as in Figure 8

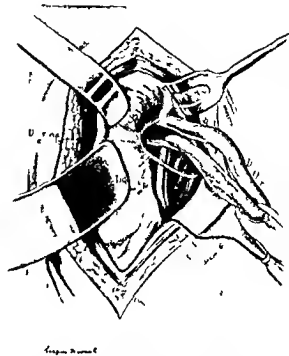


Fig 8 Ureter loop drawn below uterine vessels. Lower ureter freed and straightened to bladder

by the conservative surgery, nephrectomy is the procedure of choice. Only half a kidney can be of service in case of subsequent accident to the opposite uninjured side. Less than this can be of no real benefit and the likelihood of the persistent burden of chronic infection leaves less room for argument. These statements apply to hydronephrosis but not to all conditions. Hydro-nephrosis is often secondary to lithiasis but the surgical problems of lithiasis, with or without hydronephrosis, are apt to be quite different from those of the more idiopathic type of hydronephrosis. The surgical problems of tuberculosis and renal tumor are specific also. The one rule always applicable is utmost conservation of renal tissue when injury or disease, with exceptions as mentioned, is bilateral. Conservation in bilateral hydronephrosis is in order, but nephrectomy is preferable in every pure unilateral case of size. How this is to be determined is a matter of urological judgment based on careful correlation of

the X ray (size of kidney shadow in relation to psolectasis as indication of amount of renal parenchyma), of renal function (functional improvement with retention ureteral catheter or after preliminary nephrostomy), and of exploration (check of the aforementioned indications by inspection and palpation at the time of surgery).

A group of cases that illustrate principles of bilateral injury and repair have interested me for many years. They follow lower ureteral and vesical neck obstructions that lead to marked dilatation, elongation, and angularity of the ureters which is usually localized first at the lower third and mid ureter, but when advanced involves the whole ureter. There is, of course, an hydro-nephrotic atrophy of the renal parenchyma which is usually disproportional to the ureteral change. Large pelvic dilatations, as after obstruction at the ureteropelvic juncture, do not occur, and the ureteral dilatation, elongation, and angularity of the lower portion of the ureter may be quite pronounced before much hydro-nephrotic atrophy of the renal parenchyma has occurred. Tests of function with catheters in the renal pelvis may show an almost normal ability. These hydrangular ureters, however, are definitely obstructive in themselves, and removal of the primary obstructive factor, whether a median bar, posterior

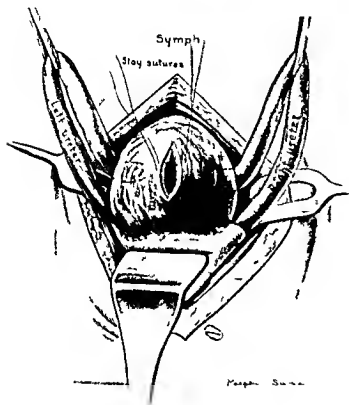


Fig 9 Bladder opened in midline

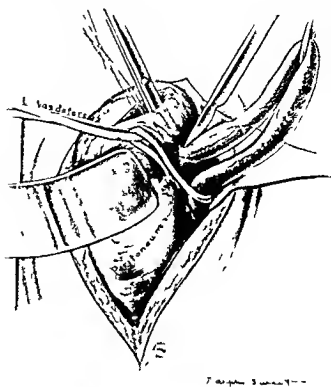


Fig 11 Incision of ureterovesical junction on clamp

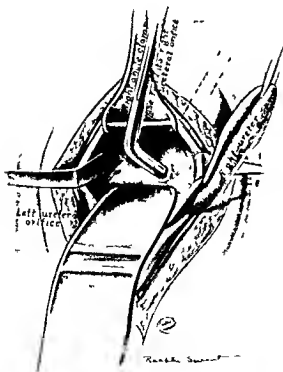


Fig 10 Right angle clamp passed through bladder into right ureter as tractor and guide for excision of ureter at orifice

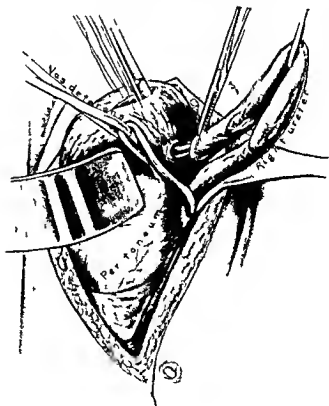


Fig 12 The cut ends of the ureter are seized in the blades of the clamp and the ureter is excised from the bladder

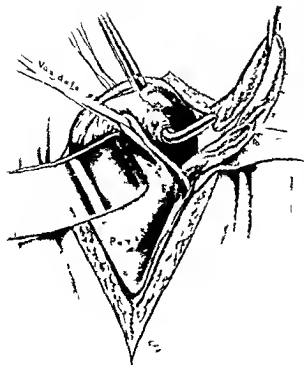


Fig. 13 Ureteral end seized in right angle clamp

urethral valve or ureterovesical defect that has led to their formation may not relieve the kidney from a progressive destruction from back pressure. This fact was demonstrated by a follow up study of a group of patients with posterior urethral valve obstructions with hydrangular ureters and hydronephrosis in whom the obstructing valve had been removed.<sup>1</sup> Subsequent functional studies often showed a gradual loss and pyelography (or cystography where the ureteral orifices are dilated) a progressive hydronephrotic atrophy. A number of these tortuous dilated ureters have been straightened and shortened surgically, often with surprising benefit functionally, which has shown no falling off even after more than 4 years. This condition is not confined to children. Typical cases occur in adults, the primary obstruction being apparently at the ureterovesical portion but obviously these patients are only partially relieved by any procedure directed solely at this portion on account of the angular loops of the ureter above, each one of which may act more or less as a valve like obstruction. The following surgery is indicated in cases of this type when

bilateral. If the condition is strictly unilateral, a finding which in our experience is rare (one case) nephrectomy is the surgery of choice for reasons already discussed, except when function of the affected side is 25 per cent (or better) of the total, when partial ureterectomy and cystoneostomy as outlined below may be in order.

The surgery of the condition is of two types according to the degree of ureteral and pelvic change. In advanced cases of the condition usually a two stage type of operation is indicated, whereas in the earlier changes of hydroangular ureters a one stage operation for both sides is all that is necessary.

The first stage of the type of operation of the advanced group consists in unilateral or bilateral nephrostomy, at which time the angular dilated loops of the upper ureter are straightened and a catheter is passed through the nephrostomy opening well down the ureter to splint it (Figs. 1 and 3). Often nephrostomy as a measure of prognosis is

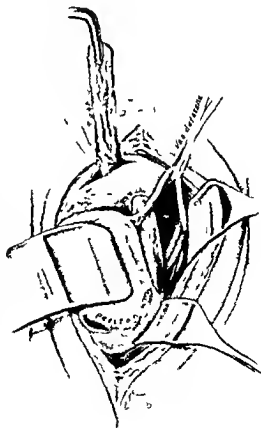


Fig. 14 Ureteral end seized and drawn up through bladder

<sup>1</sup>Hinman, Frank. Obstructive hydro-ureteral angularity with hydronephrosis in children. Surgical treatment. Arch. Surg. 1929 LVIII: 21-35.

necessary in addition to the purpose of removing tortuosities of the upper portion of the ureter that could not be satisfactorily reached from below when the angularities of the remaining portion of the ureter are relieved. Nephrostomy tubes can be left in almost indefinitely if ordinary precautions of irrigation and periodic changing of the tube is attended to. Often the complete lack of functional improvement after such a nephrostomy will clearly indicate the uselessness of any further conservative surgery and the second stage of the operation would be abandoned.

In those less advanced cases in which the upper ureter is fairly straight, the whole repair procedure may be done through a midline suprapubic incision, through which the peritoneum is stripped back from the lateral abdominal wall on either side and the ureters are exposed extraperitoneally (Fig 2). In the exposure of the ureter for most of its length extraperitoneally, the deep epigastric

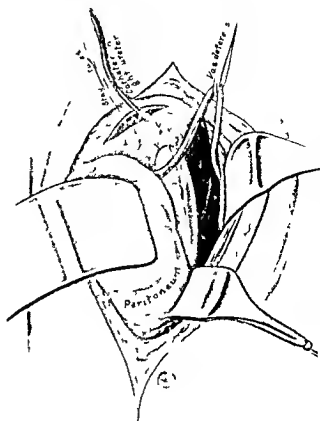


Fig 16

Fig 16 Interrupted sutures anchoring ureter to external bladder surface and redundant ureter removed

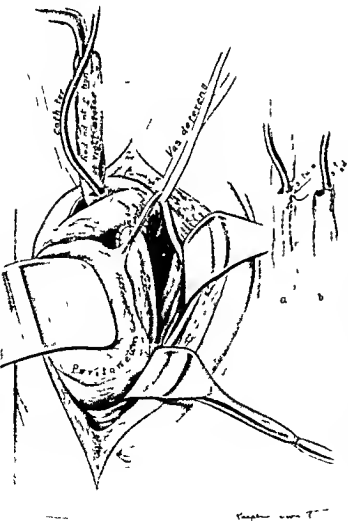


Fig 15 Interrupted sutures anchoring ureter to external bladder surface

vessels usually have to be divided and the entrance to the bladder over the vas deferens or uterine vessels must be recognized. The relation to the vas deferens is shown in Figure 4. In stripping laterally, the vas deferens is usually the first to be encountered and a tape is placed under it to localize it, and the peritoneum is then stripped backward, thus exposing the large iliac vessels. Usually the ureter can be seen as it passes over the brim of the pelvis, but often it is more or less adherent to the peritoneum and strips back with it (Fig 5). When located at the pelvic brim, the ureter is quite readily freed at this point, but may be more or less adherent toward the bladder as well as toward the kidney (Fig 6). After the ureter has been freed, it is drawn below the vas deferens or uterine vessels, as shown in Figures 7 and 8, and then the bends and tortuosities are fully removed by division of the adhesions and fibrous bands. When straightened, the ureter is found to be very much lengthened, as shown in Figure 9, and it is the next step of the operation to take up this slack and leave the ureter comfortably straight. This is done quite satisfactorily by passing a right angle clamp through the ure-

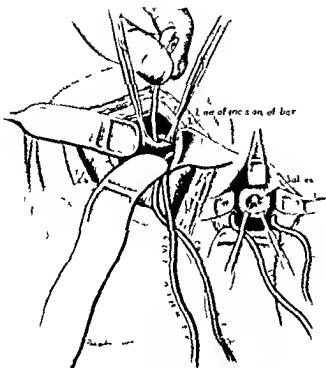


Fig. 17 Removal of bar at neck of bladder

teral orifice intravesically, as shown in Figure 10. Where the orifice is small and this cannot be done, the ureter can be opened extravesically and the orifice dilated sufficiently to allow the insertion of this clamp. Such a dilated orifice is required anyway for satisfactory implantation of the hydro ureter. The bladder is held aside and the ureter then divided at the ureterovesical junction on the curved clamp, as shown in Figure 11, and the cut ends of the ureter are then seized in the blades of the clamp, as shown in Figures 12 and 13, and the ureter is drawn through into the bladder as shown in Figure 14, until enough of the extra length passes to leave the remainder straight loose, and satisfactory. The ureter is fastened by interrupted stitches extravesically (Fig. 15) and the redundant portion resected. Usually a considerable portion of the ureteral wall is left projecting into the bladder. A retention catheter is placed through this and sutured to the edge of this intravesical portion. Not too large a catheter is desired, usually a No. 14 to No. 16 and,

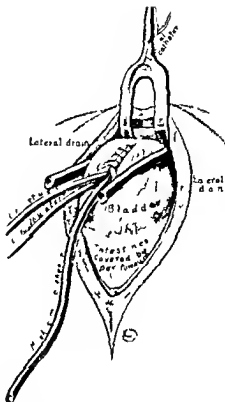


Fig. 18 Drains in place and abdominal incision ready for closure

if the ureter is markedly dilated, it fits quite loosely about this size catheter. In order to allow free drainage into the bladder alongside the catheter and thus prevent any retention sac the ureter is not tied by a circular suture (Fig. 15 a and b). If indicated, the opposite ureter is treated in a similar manner (Fig. 16).

At this stage or previous to the ureteral implantation at the option of the operator, any obstructive condition remaining at the vesical neck should be radically treated. A median bar or a posterior urethral valve can be quite satisfactorily reached transvesically, as shown in Figure 17. A mushroom catheter, or any suprapubic catheter desired is placed in, the bladder sewed over this, and the two ureteral catheters for drainage tubes placed in each fossa, and usually a urethral catheter placed for purposes of through and through irrigation (Fig. 18).

## CARCINOMA AND TUBERCULOSIS OF THE STOMACH

## REPORT OF A CASE WITH A REVIEW OF THE LITERATURE

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THE relative infrequency of tuberculosis of the stomach, as is shown by Broder's review of the literature in 1917, and the rarity with which it occurs in conjunction with carcinoma of the stomach, has made it appear worth while to report this case and at the same time to summarize the cases, 13 in all, reported in the literature.

In 1897, Lowenheim is said to have reported a case of a patient dying of chronic pulmonary tuberculosis in whom a necropsy revealed numerous, typical tubercles in the submucosa of the stomach between the glands of an adenocarcinoma. There were no tubercles in the mucosa. It is not stated whether or not acid fast bacilli were found. The author believes that the tubercle bacilli reached the stomach via the blood stream and that the tuberculosis acted as an irritant and produced the carcinoma. We have been unable to verify this reference. It is, however, cited by Gustav Frank.

Claude, in 1899, reported the case of a man who entered the hospital because of intestinal tuberculosis. There were no clinical symptoms to draw attention to the stomach. At necropsy were found tuberculous lesions of the large intestines, caseous masses at the apices of both lungs, a fatty liver which was slightly jaundiced. Examination of the stomach showed an irregular, rounded tumor near the pylorus which measured 6 by 4½ centimeters. This tumor was pink and was surrounded by a slight ulceration. A short distance from the tumor were several small nodules the size of a pea. Microscopic examination proved the tumor to be definitely malignant. At its periphery were several tubercles, containing caseous material in which acid fast bacilli were demonstrated. The author believes that the tuberculosis was superimposed on the carcinoma.

In 1900, Simmonds reported a case of a man who died at the age of 40 years with intestinal and pulmonary tuberculosis. At necropsy a cancerous nodule, measuring about 2 centimeters (hazelnut size) in diameter, was seen at the pylorus. A short distance from this tumor several small tubercles, about 4 to 6 millimeters in diameter were seen. The author believes that the carcinoma, which resulted in a reduction of hydrochloric acid in the stomach, increased the susceptibility of that organ to tuberculosis.

In making an histological study of 63 stomachs removed at operation for carcinoma, Borrmann, in 1901, was able to find both carcinoma and tuberculosis in two cases. The first of these was a woman aged 60 years, who had been sick for 3 months. At operation a large, circular carcinoma, composed of cylindrical cells, was found. Microscopic examination showed a large number of typical tubercles with caseous centers in the older parts of the tumor while one small tubercle with one giant cell was seen in the younger part. The second case is that of a man, aged 53 years, who had been sick for 6 months with carcinoma of the stomach. A tubercle, composed of ten giant cells, was seen in the mucosa. This tubercle was completely surrounded by carcinoma. Necropsies, performed on both of these patients, showed no evidence of tuberculosis anywhere else. There is no statement as to whether or not acid fast bacilli were looked for. The author believes both of these to be typical cases of *Futterungstuberkulose* (tuberculosis conveyed by the food). In cases of carcinoma of the stomach he believes that the tubercle bacilli remain in the stomach for a longer time and that the change in acidity gives them a better chance to become implanted.

Borst, in 1902, stated that in one case of pulmonary tuberculosis he saw a large number of tubercles combined with carcinoma of the stomach. No further information was given.

In Barchasch's case (1907) a man, aged 45 years, had been sick from 1½ to 2 years. His condition was diagnosed carcinoma of the stomach. Clinically no evidence of tuberculosis was found. At necropsy a carcinoma of the cardiac orifice of the stomach with metastases to the regional lymph nodes, old pulmonary tuberculosis, and a solitary tubercle in the mucosa near the pylorus of the stomach were found. Acid fast bacilli were demonstrated in this tubercle. The author believes that, in this case, the tuberculosis was superimposed on the carcinoma.

Melchior, in 1913, reported the instance of a man, aged 55 years, who had symptoms of pulmonary tuberculosis for 3 months and was found at necropsy to have tuberculosis of the lungs, pleura, and intestines. The stomach contained a large tuberculous ulcer, which extended from the

cardia to the pylorus. In the region of the pylorus, the stomach was thickened, and the pyloric outlet was partially closed. Sections taken in this region for microscopic study showed an adenocarcinoma.

The case of a man, aged 40 years, who for many years had had a "weak stomach" is reported by Frank in 1913. Eight months before the patient entered the hospital emaciation had become pronounced. On examination a large tumor was found in the epigastrium. The stomach contained no free hydrochloric acid and was dilated. It was found impossible to remove the tumor at operation, a posterior gastroenterostomy was performed and exitus occurred a short time afterward. Necropsy showed old pulmonary tuberculosis with cavitation, a large ulcerated tumor at the pylorus which partially closed the pyloric orifice, tuberculosis of the lymph nodes around the stomach and in the mesentery. Microscopic examination showed several, small, caseous tubercles, with caseous centers, at the border of the carcinoma. These tubercles were seen in both the muscularis and submucosa. None was found in the mucosa. No acid fast bacilli were encountered, but Frank thinks that this was due to the fact that the tissue had been fixed in formalin. The author believes that, in this case, the tubercle bacilli reached the stomach through the blood stream, as there were no tubercles found in the mucosa of the stomach.

In 1913, Lyle described an instance of a man aged 40 years, who smoked and drank to excess. Four years before death, he was operated on for fistula in ano. He had a "stomach cough" for over a year and a dull pain in the region of the stomach for 5 months before death. Vomiting which came on 3 or 4 hours after eating commenced 4 months prior to death and persisted. The vomitus was composed of food taken at the last meal. At operation a large mass was found in the stomach and a partial gastrectomy was performed. The tissue removed was diagnosed carcinoma. In the submucosa there was a coagulation necrosis and several giant cells and epithelial cells. Death occurred 2 months after operation, and at necropsy pulmonary tuberculosis and miliar tuberculosis of the peritoneum were found.

In Anschultz and Konjetzny's case (1921) no history or details were given. The report only stated that in a case of carcinoma of the stomach caseous tubercles were also found in the stomach.

Hamperl, in 1926, reported an instance of a female, aged 68 years, who complained of pain in the stomach. A large mass was palpated in the region of the pylorus. At operation two thirds

of the stomach was removed. The mass proved to be a carcinoma solidum. Numerous sections were taken and one showed a mass of epithelioid and giant cells.

In 1926, Faltin reported a case of a man, aged 60 years, who had for years suffered from his lungs and stomach. He was admitted to the hospital because of his stomach condition. There were suspicious alterations over the right lung, but acid fast bacilli were never found in his sputum. The stomach was resected and a large, ulcerous, stenosing tumor was found in the neighborhood of the pylorus. Microscopic examination showed tuberculous alteration and a big tuberculous ulceration with adenocarcinoma at the bottom. The lymphatic glands along the lesser curvature were also tuberculous. Acid fast bacilli were not found, but the histology showed epithelioid cells, giant cells, and necrosis, so that the author does not doubt that the process was tuberculous in origin. He believes that this case is one of a tuberculous ulcer of the stomach on which the carcinoma had developed.

In our own case, W. M., a Russian Jew, aged 70 years, had been troubled for 4 months with epigastric discomfort after eating. This was occasionally followed by vomiting which had caused him to restrict his diet. About 8 months after the onset of these symptoms, constipation became a dominant feature. Just before admission to the hospital he had a sudden attack of persistent vomiting and a colic like pain over the abdomen. He was admitted on the Surgical Service of the New Haven Hospital.

On admission to the hospital the temperature was 101.2 degrees F., the pulse rate was 104 per minute and the respirations 22 per minute. An exploratory laparotomy revealed the abdomen to be filled with a cloudy, thick yellow fluid. The stomach near the pylorus was composed of a firm, cancerous tissue and large, firm lymph nodes were felt in the gastrocolic ligament. The whole mass was covered with a fibrinopurulent material. A jejunostomy was made and the abdomen closed. After operation the patient grew gradually weaker and death occurred 23 days after admission.

**Necropsy report.** The examination was performed 3 hours after death. Only the findings bearing on the subject are included here in detail. The body is emaciated and weighs 35.5 kilograms. The peritoneal cavity does not contain any free fluid. The peritoneal surfaces are dull and opaque. There are numerous fibrous adhesions between loops of intestines, stomach and liver and diaphragm. Many of the mesenteric lymph nodes contain caseous material. The pylorus of the stomach is contracted so that the lumen measures about 5 millimeters in diameter. Extending from the pylorus for 10 centimeters and almost completely encircling the stomach wall, there is a mass of tissue measuring about 1 to 2 centimeters in thickness. The edges of this mass are heaped up and the center part is depressed. It resembles a healed ulcer. In the middle of this mass there is a perforation measuring about

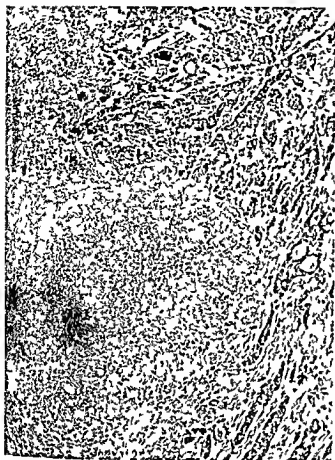


Fig 1 Microscopic preparation through wall of stomach showing carcinoma and tuberculous necrosis with one giant cell  $\times 65$



Fig 2 Microscopic preparation through the same field as shown in Figure 1 near the giant cell showing two acid fast bacilli  $\times 1200$

5 millimeters in diameter which opens on to the surface of the liver and is surrounded by dense fibrous adhesions. A cross section of the mass is translucent, although there are several opaque dots seen in it. The wall of the remaining portions of the stomach is slightly thickened and the lumen is small. Near the cardiac orifice there is a round mass measuring 2 by 2.5 centimeters which is attached to the stomach by a thin pedicle. A cross section of this mass shows a circumscribed mass of pale, white, translucent tissue, in which several red dots are seen.

Microscopic preparation shows the architecture of the stomach to be completely distorted in the thickened and ulcerated area near the pylorus. The mucosa is replaced by cells which have vesicular nuclei and an occasional mitotic figure. These cells are arranged in a manner which somewhat resembles the normal glands of the mucosa. Between these pseudo glands there is some fibrous tissue. These cells are heaped up near the edge of the ulcer and extend down through the submucosa into the muscularis. Scattered throughout the tissue numerous mononuclear cells are seen. The serosa is greatly thickened and is composed of fibroblasts, small round cells, and plasma cells. An occasional small mass, of the same type of cell as described in the mucosa, may be seen. A section taken where the stomach and the liver are adherent shows the same picture in the mucosa and submucosa, but in the muscularis and serosa masses of cancer cells are seen next to masses composed of cellular debris. In this area there are several giant cells of the Langerhans type which are surrounded by small round cells and epithelioid cells. Acid fast bacilli are demonstrated in this area. Sections taken

through other parts of the stomach show nothing remarkable in the mucosa and submucosa. The outer layer of the muscularis contains several giant cells of the Langerhans type, surrounded by round and epithelioid cells. The serosa is greatly thickened and similar to that described above. A section through the polyp shows it to be completely surrounded by mucosa which shows nothing remarkable. The remainder of the polyp is composed of fibroblasts, among which are seen numerous round cells with vesicular nuclei. This fibrous tissue extends down through the submucosa into the muscularis.

The complete anatomical diagnosis of this case is: Primary (a) Carcinoma of the stomach with metastasis to regional lymph nodes, diaphragm, mesenteric and colic lymph nodes, pancreas, liver, peritoneum, and splenic capsule with invasion of the splenic tissue, (b) chronic ulcerative and proliferative pulmonary tuberculosis, pleural adhesions, tuberculous lymphadenitis (abdominal and bronchial), tuberculosis of stomach, spleen, liver, and peritoneum. Subsidiary thrombus in pudendal veins, myoma of the stomach.

Of the 14 cases reviewed here, 6 are mentioned in Broder's report, where they are classified either as proved or probable cases of tuberculosis of the stomach. With the exception of Lowenheim's case, a description of which could not be found, we believe that the same classification holds true for the 8 remaining cases, including our own. In



every instance either acid fast bacilli were found or the descriptions both gross and microscopic, present a typical picture of tuberculosis.

The diagnosis of tuberculosis on a morphological basis alone is, of course, always open to question unless the disease can be reproduced by animal inoculation. In these instances this was never done. In our own case, animal inoculation was attempted but unfortunately the animals died of an intercurrent infection shortly after inoculation. However, we feel that the finding of acid fast bacilli, together with the usual histological picture of tuberculosis makes the diagnosis practically certain. Acid fast bacilli were demonstrated by Barchasch, Claude, and in our own case.

Borrmann, Simmonds, and Barchasch believe that in their cases the hydrochloric acid was decreased by the carcinoma and hence that the tubercle bacilli were not killed but remained in the stomach. Frank, Claude, and Lowenheim think that, since all tubercles are found in the submucosa, the infection reaches the stomach through the blood stream. None of the cases is explained on the basis of infection along the lymphatics. Our own case appears to be one in which the infection spread from the peritoneum into the wall of the stomach by direct extension.

We feel that, with the available data it is impossible to say what effect the carcinoma or the tuberculosis had in the presence of the other disease. We do not believe, with Borrmann, Simmonds and Barchasch however that the presence of carcinoma favored tuberculosis by retaining the tubercle bacilli for a longer time and under more favorable conditions. Were this the case, one would expect to find tuberculosis in a far greater proportion of the cases of carcinoma of the stomach than actually occurs.

## SUMMARY

A case of carcinoma and tuberculosis of the stomach is reported and 13 cases are cited from the literature.

No attempt is made to explain the simultaneous occurrence of the two diseases, as it is felt that as yet insufficient data has been collected on the subject. It is the author's opinion, however, that the theory of Borrmann, Simmonds, and Barchasch as to the effect of the carcinoma on the tuberculosis is untenable.

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## CONGENITAL DISLOCATION OF THE HIP

## AN OPERATION FOR DEFECTIVE ACETABULUM

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ANYONE proficient in one of the well tried methods of reduction of congenital dislocation of the hip may obtain a satisfactory reduction in a large percentage of cases if the patients are young and bone development is not deficient. If the dislocation cannot be reduced or if it will not remain reduced because of bone deficiency, something more must be done.

Beside abnormality in the soft parts and changes in the head and neck of the bone in congenital dislocation of the hip, marked changes in the acetabulum were present in 41 per cent of our cases not operated upon. The acetabulum may be deep, covering the head of the femur completely, or shallow and cover it only partly, or not cover it at all. The acetabular roof or shelf may be horizontal, as in normal children, or it may be oblique. When it is oblique but not markedly so, it does not affect the result any more than if it were a normal or horizontal roof. However, when the obliquity is 30 or less degrees from the vertical, the reduction of the hip may be successful but, unless we have been successful in forming an acetabulum which will hold the femur, the head of the femur slowly migrates upward in a few years, and disability follows. In such cases shortening also takes place.

In successfully reduced cases, in which there is a very poor acetabular shelf, assurance against redislocation with the maintenance of normal function can be obtained by implanting a bony shelf above the femoral head.

It must be remembered that certain cases of congenital dislocation of the hip, with an almost vertical acetabulum, may be reduced and remain reduced for 1 or 2 years. After reduction, we have found in some cases that the acetabulum improves in depth and in its overhanging roof, so that nothing further has to be done to secure a permanent and satisfactory result. In other patients less fortunate who have dislocations too old for reduction, a bony shelf may be placed in the ilium above the head of the femur. This will give a bony shoulder to bear the body weight. In such cases, the head of the femur should be brought down as low as possible and placed as far forward in an anterior position as possible before the bony shelf is made, because (1) there is less abnormal tilt in the pelvis when the head

of the femur is anterior, and (2) the ilium is thicker anteriorly and therefore provides a better and a more substantial base for the implantation of a shelf.

The operation of making a bony shelf in such cases has been done for many years. Recently, however, the importance and value of the method have been realized more than ever and efforts are being made to perfect the technique so that the operation will be more generally used.

Probably the first operation of this type was done by Koenig in 1893, later it was done by Ridlon and Ferguson (1904), Jackson Clarke of London in 1909, Albee in 1913, and Ellis Jones in 1920. Later, it was used by N. Fairbank of London, Lambeau, Vance, Delageniere, Mauclair, Dujarier, Hallopeau, Spitzzy, Dixon, Allison, Swett, Wallace, Ober, Bruce Gill, etc.

The bony shelf has been proved by many to be of great advantage in both young and old, it relieves pain and fatigue, helps to improve locomotion, and maintains the length of the leg.

The principal feature of the operation is the turning down of part of the ilium above the head of the femur, and the placing of a tibial graft above in the space where the ilium is bent down. In one instance, Hallopeau used dead bone as a graft. Spitzzy placed a tibial graft in the head and

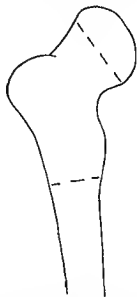


Fig. 1. Dotted line represents the limits of the graft removed from the neck, trochanter, and shaft of the femur.



Fig. 2 X-ray shows the graft implanted in the ilium and the outer table of the ilium slanted out and resting against it (Notice thickness of the graft which is driven through a slot in both tables of the ilium)

neck of the femur and made it transfix the ilium, and also placed above this a tibial graft

The writer wishes to describe a procedure which is satisfactory, simple and rapid and which embraces the principles of the methods mentioned but which involves less operative work in that only one incision is required for the exposure of the operative site and the procuring of the graft. The graft obtained is thick and stands out from the ilium. It is broad in that it covers the head of the femur, and it is big enough to be driven solidly into the ilium and still stand out well. It is in contact with bone at its outer margin thus insuring long life. A triangular space is shut in by three surfaces of bone, which is filled in later by solid bone (Fig. 3)

#### OPERATION

An incision is made from the anterior superior spine of the ilium to 2 centimeters below the top of the trochanter and then backward and upward. The soft parts are reflected upward, thus exposing



Fig. 3 Outline of the graft in position driven into the slot above the acetabulum with the bone chiseled from the outer table of the ilium resting above against the ilium and below against the graft. At this point it is sutured to the graft which is firmly imbedded in the ilium

the capsule of the joint a slot is made through the outer and inner table of the ilium (Fig. 3), just above the head of the femur and extending some distance posteriorly and anteriorly. This slot is cut with an osteotome and is made sufficiently broad and long to hold a good size piece of bone. A square is cut from the outer table of the ilium above this (Fig. 3) and separated from the ilium at its lower edge and at its sides, while the upper edge remains in contact with the ilium (Fig. 3)

A graft is taken from a portion of the trochanter and the adjoining neck and shaft of the femur (Fig. 1) posteriorly (or anteriorly) and cut thick and large enough to cover a wide space above the head of the femur. This method of securing the graft simplifies the operation and eliminates the necessity of making a separate incision to obtain the graft. The graft is driven into the ilium. The square piece of bone which was cut from the outer table of the ilium above the acetabulum is lowered and remains in contact with the ilium at its upper edge. Its lower edge is fastened to the outer edge of the femoral graft with one catgut suture. The soft tissues hold this

in place as they are firmly sutured over it. Its upper edge may be shortened in the middle, making this piece of bone longer at the sides than in the middle. These longer sides can be fitted into slots in the ilium, if necessary.

This method is also applicable in cases in which the head of the femur is high on the ilium and is reduced. In this type of case it is not possible to make a socket as the bone is thin, and a substantial piece of bone cannot be turned out. A shelf of bone, however, can be implanted into any part of the ilium. I have also used a piece from the crest and adjoining ilium, from the quadrilateral piece subperiosteally. This is as heavy as a trochanteric graft and requires a separate incision. A large amount of bone is deposited between these surfaces of bone and the outer edge of the graft away from the ilium will have bony contact, thus making it more permanent. A curved acetabular roof may be necessary in certain cases. In this operation, it is almost straight. A graft of substantial size is sufficient, provided it is well placed and provided it extends out broadly either side of the head of the femur.

I recommend this way of implanting a shelf and of obtaining a very substantial graft from the neck, trochanter, and shaft of the femur with a sloping piece of bone from the outer table of the ilium, which stabilizes the shelf and thereby makes bony contact at its outer edge.

In over 3 years, I have used the operation in 9 cases and while the patients have been substantially benefited, it is too soon to judge the ultimate results. The ages of the patients varied from 6 to 18 years.

The operation is done to secure a good bony shelf, and thus improve weight bearing, decrease fatigue, and improve locomotion. It may be used if the ilium is not thick, in fact, the method has proved as successful as did the method of turning down the ilium and placing the tibial graft above the acetabulum. At the same time we secure a thicker and larger shelf and the operation is easier to perform as it requires but one operative field. Another advantage is that it can be done rapidly.

I would emphasize again that we can secure a satisfactory graft either from the anterior or posterior portion of the surface of the trochanter and neck and shaft of the femur. The graft may be made of very satisfactory shape, it may be cut broad, long, and thick. When it is driven into the ilium solidly above the head of the femur, it is firmly implanted and will not easily be displaced. It may be reinforced by the piece of bone cut from the outer table of the ilium (Fig. 3). This is not necessary but gives added strength.

Something must be done to maintain reduction in those cases that have defective bone formation at the time of operation and something must be done to improve function in those cases that cannot be reduced. This operation will give a shelf in both types of cases and is a comparatively simple procedure and has proved satisfactory.

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## MELCHANICAL AND ANATOMICAL PRINCIPLES OF OPERATIONS FOR DROP FOOT

### SUGGESTED NEW OPERATIONS<sup>1</sup>

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THE ankle joint is a complicated hinge joint composed of the talus inferior end of the tibia, and the respective malleoli of the tibia and fibula. Articulating cartilage covers the contiguous surfaces.

The convex surface of the talus is broader in front than behind and is approximately twice the length of the concave surface of the tibia. Grooves or notches appear on the neck and posterior end where the talus impinges with the respective margins of the tibia when the foot is fully dorsiflexed or plantar flexed. Occupation and habits determine the size, depth and structure of the impinging surfaces. Distinct articulating facets (Morris) have been reported on the bones of ancients and orientales.

#### ANKLE JOINT MECHANICS

Although the motion occurring between the concave tibia and convex talus resembles a hinge joint, the actual transverse axis passes through the tips of the malleoli and body of the talus considerably below its articulating surface.

This hinge motion has been variously estimated ranging from 45 to 60 degrees of dorsiflexion to

115 to 145 degrees of plantar flexion. The ankle mortise permits very slight forward motion of the tibia on the talus, but negligible lateral motion.

Dorsiflexion is normally limited posteriorly by (1) the plantar flexor muscles and (2) the talo tibial and talofibular ligaments, anteriorly by impingement between the neck of the talus and the anterior margin of the tibia, mesially by posterior part of the deltoid ligament, and laterally by the calcaneofibular ligament.

Plantar flexion is normally limited anteriorly by (1) the dorsiflexor muscles (2) the talotibial ligaments (3) the tibionavicular ligaments and (4) the talotibular ligament posteriorly by impingement of the posterior groove of the talus and the margin of the tibia, internally by the anterior part of the deltoid ligament.

Forward motion of the tibia on the talus is prevented by (1) interlocking of the convex talus and concave tibia, (2) wedging of the ankle mortise on the increasing width of the body of the talus, and (3) anteriorly by the talotibial, tibionavicular, and the talofibular ligaments.

Lateral motion is prevented mesially by (1) the internal malleolus, (2) by the deltoid ligaments and its components, the talotibial, calcaneotibial,

<sup>1</sup>This treatise is based upon studies made in the Laboratory of Anatomy at the Grainger Medical School of the University of Tennessee.

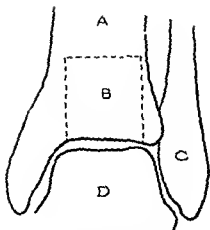


Fig 1

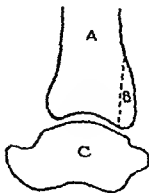


Fig 2

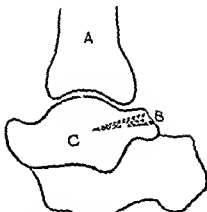


Fig 3

Fig 1 1, Posterior view of tibia, B, outline of bone graft, C posterior view of fibula, and D talus

Fig 2 A, Side view of tibia, B side view of graft showing its wedge shaped appearance, and C talus

Fig 3 1, Side view of tibia, B, bone chips wedged into the osteotomy of the talus, and C, talus

and the tibionavicular ligament, and laterally by (1) the external malleolus and (2) the calcaneo fibular and the talofibular ligaments

#### MECHANICS OF DROP FOOT DEFORMITY

Paralysis of the dorsiflexors permits the unbalanced plantar flexors, assisted by gravity, to draw the foot plantarward into the drop foot position. The paralyzed structures stretch and relax while the plantar flexors contract and shorten. The extreme limit of plantar flexion is registered when impingement occurs between the posterior groove of the talus and the margin of the tibia.

There may be an additional dropping of the forefoot called "metatarso equinus," which takes place at the mid tarsal junction and is confused with typical drop foot.

Literature and statistics are not available regarding the erosion or pressure atrophy that occurs at the points of contact on the talus and tibia after years of service. Since these structures are normally endowed with bone checking properties, it is entirely reasonable to assume the existence of a maximum resistance to atrophy.

#### IDEAL BONE CHECKING MECHANISM

These normally impinging surfaces, by virtue of their mechanical structure and strategic location, make an ideal bone mechanism for resisting or checking plantar flexion. Although, apparently ideal in arrangement, this anatomical bone blocking device is not utilized by the popular surgical procedures for the correction of drop foot deformity.

The present cadaver studies were undertaken with the object of developing a surgical technique utilizing this anatomical mechanism.

#### REVIEW OF BONE BLOCK LITERATURE

Several bone block operations for drop foot have been described. Only one, however, could be found depending entirely upon this anatomical device.

C Lambrinudi records an operation, in which he reconstructs the head and neck of the talus and transposes the fragments for a wedge under the posterior end so that the talus is almost vertical. The normally impinging surfaces of the talus and tibia thus prevent plantar flexion. Mechanically it fulfills our ideal bone checking requirements. He reports 9 operations with 2 technical failures.

Our cadaver studies verified his mechanical conclusions, but also demonstrated the operation to be technically difficult as a laboratory procedure.

Campbell employs a bone blocking device constructed of new bone and does not entirely utilize the anatomical mechanism. Both of his operations require the removal of the posterior end of the talus. His first procedure (1) replaces the end of the talus with a pillar of bone obtained from an associated tarsal arthrodesis. This newly constructed bone impinges with the posterior surface of the tibia. Campbell's second operation (2) replaces the posterior end of the talus with a bone pillar made by turning up successive shavings from the upper surface of the calcaneus. This new bone also impinges with the posterior surface of the tibia.

Both of Campbell's operations are popular and apparently successful. The technique on the cadaver is simple but impresses one with its possible frailty. Several fractures of the new bone pillars have been reported and pressure atrophy is a probability.

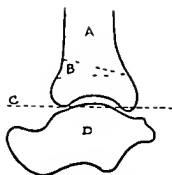


Fig 4

Fig. 4 1 Side view of tibia, B outline of wedge shaped osteotomy, C plane of ankle joint and D talus

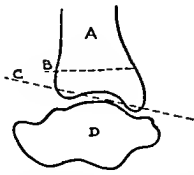


Fig 5

Fig. 5 A Side view of tibia, B, line of old osteotomy

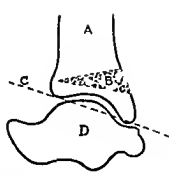


Fig 6

C plane of ankle joint and D talus

Fig. 6 1 Side view of tibia, B linear osteotomy wedged open, C plane of ankle joint and D talus

#### SUGGESTED BONE CHECKING OPERATIONS

The bone checking operations here described we believe are unpublished and clinically untried. They are presented only as surgical laboratory procedures. It is possible that they may have clinical application in selected cases. Although bone blocking operations are alone seldom sufficient and are usually associated with appropriate combinations of arthrodeses and tenoplasties, these associated procedures will not be discussed.

Except for the anterior wedge shaped osteotomy, later to be described, the operative approach is by the usual Z shaped division of the Achilles tendon and need not be presented in detail. This approach will permit free exposure of the lower posterior 2 or 3 inches of the tibia, ankle joint, and the talocalcaneal joint.

**Sliding tibial graft.** Upon the posterior surface of the tibia, schematically represented in Figure 1, outline the area of the graft, which should be about the full width of the ankle mortise and extend up the shaft about  $1\frac{1}{2}$  inches. With a circular saw or preferably an osteotome cut to a depth of about  $\frac{1}{2}$  or  $\frac{3}{4}$  inch. Mobilize the graft from above downward by means of a wide beveled chisel. Begin as though it were to be an osteoperiosteal graft and increase the depth as the joint is approached, as shown in Figure 2. The one essential thing is to include within the graft the impinging joint margin of the tibia. Slide it down until the graft engages with the posterior end of the talus when the foot is held at a right angle. If the graft is the full width of the ankle mortise the two distal corners, enter the insertion of the capsular ligaments on the tibia, and provide sufficient tissue for suture attachment. The graft may be anchored by metal or bone screws, sutured to the sides of its bed through drill holes, or, better still, sutured to the capsular ligaments.

Should the graft alone seem insufficient it can easily be reinforced by bone chips taken from the tibia or from an associated arthrodesis.

Since all cadavers in our series were of adults it was quite impossible to determine the full effects of the operation on the epiphysis. It is significant, however, that of the 213 cases reported by Campbell (3) more than half were in adults in whom the epiphysis would not be involved. The operation is not itself an emergency measure and might easily be delayed to a period of election.

**Osteotomy of the talus.** Fully expose the posterior structures of the ankle and arthrodesis the talocalcaneal joint from behind then sharply dorsiflex the foot rendering the posterior end of the talus clearly visible. With a wide osteotome cut the full width of the talus, parallel to and about  $\frac{1}{4}$  inch below its upper articulating surface as illustrated in Figure 3. Enter the substance of the talus for at least  $\frac{1}{2}$  inch or more and make a greenstick fracture upward.

This fragment bearing the grooved area for impingement with the tibia, may be wedged up by small bone chips, obtained from the arthrodesis.

In one of the cadavers employed for this study there was an os trigonum or accessory bone making up the posterior end of the talus which rendered this operative procedure impossible. The upper surface, however, was grooved exactly as if it had been the talus.

**Osteotomy of the tibia.** Represent the plane of the ankle joint by a straight line touching the anterior and posterior lips of the tibia, as illustrated in Figure 4. It is obvious that any mechanical scheme that will elevate the anterior lip or lower the posterior lip will alter the joint plane and incline it backward as shown in Figure 5. Plantar flexion of the foot will thus be restricted. The anterior margin can be elevated by a wedge shaped

osteotomy from the front or the posterior margin may be lowered by a linear osteotomy wedged open from behind.

Approach the anterior lower end of the tibia through a longitudinal incision placed to the mesial side of the extensor tendons. With the tendons retracted outward perform an anterior wedge-shaped osteotomy near the joint. It is seldom necessary to make the wedge more than  $\frac{3}{4}$  inch thick at the base. However, enough should be removed to permit impingement of the talus and tibia when the foot is at a right angle.

Inclination of the joint plane may also be obtained by a linear osteotomy on the posterior surface of the tibia, wedged open about  $\frac{3}{4}$  inch. After the tibia is cut through sharply dorsiflex the foot and wedge bone chips into the gaping osteotomy until the talus and tibial margin meet, when the foot is released back to a right angle, as illustrated in Figure 6.

When either type of osteotomy is near the joint, considerable inclination of the ankle plane can be obtained without noticeable deformity. It is generally advisable to accompany the tibial osteotomy with a division of the tibiotalar ligament, if a thick edge is removed from in front or inserted behind.

The majority of drop foot cases necessitates a lengthening of the Achilles tendon and would con-

sequently render some posterior type of operation preferable. When Achilles tenoplasty is required an anterior osteotomy of the tibia is the procedure of election.

#### SUMMARY AND CONCLUSIONS

1. Four bone block operations are the relief of drop foot deformity.
2. Although the four operations are different, they all utilize the anatomical impinging mechanism between the tibia and talus.
3. These operations are clinically unpublished and are presented only as laboratory procedures, with the belief they may have clinical application.

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## HERNIA OF THE OVARY AND FALLOPIAN TUBE

## A RECORD OF TWENTY FIVE CASES

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ALTHOUGH hernia of the ovary and tube has been recognized and discussed from early times, it is only of recent years that any important papers have been published on the subject. Watson in 1923, was able to collect 175 cases of hernia of the ovary and tube from the literature on the subject.

Although the site of the hernia varies it may be said that about 90 per cent of hernia of the ovary and tube are of the inguinal variety. In my series 22 were of this type. Next in frequency is the femoral variety which, however, is uncommon only 3 out of my 25 cases coming under this classification. Although such rare conditions as obturator and sciatic hernia of the ovary and tube have been recorded they must be looked upon as extremely rare, no such case occurred in my series. In the 22 cases of inguinal hernia the ovary and tube were present as well. In the 3 cases of femoral hernia, however, in only 1 case did the fallopian tube accompany the ovary into the peritoneal sac. This seems to be the usual state of affairs, namely that inguinal hernia of the ovary without the fallopian tube can be looked upon as very uncommon, while in the femoral variety it is more common to find the ovary without the tube.

Among my cases there were none in which a pregnancy had taken place in the tube, but this is a possible complication which must be taken into account. Of 68 cases of hernia of the fallopian tube collected by Watson in 1923 from the literature of the subject, there was tubal pregnancy in 11. Ovarian pregnancy has also been recorded, but it is very rare. Probably the most frequent pathological change in old standing cases is cystic degeneration of the ovary. Large ovarian cysts have been removed from hernial sacs. Grant, in 1920, described an ovarian cyst which measured nearly 6 inches in length as occurring in a femoral hernia. A very few cases have been recorded in which malignant disease has supervened on a herniated ovary.

The cause of hernia of the ovary and tube is a very moot point, and for the lack of a better explanation we are constrained to fall back on a very wide term and say it is due to congenital predisposition. There can be no doubt, when look-

ing through the published cases of this condition that the majority occur in girls under 1 year of age. The canal of Nuck is normally obliterated about the eighth month of intra uterine life, but remains patent in some cases throughout life. The ovary does not, as a rule descend into the pelvic cavity until the end of the first year of life, and this may be the reason why so many cases occur before this date. In women it is more common to find the condition in those who have had several pregnancies, and in all probability this is due to the far greater mobility of the ovary and tube in such cases. In young children after one year other factors may act as exciting causes, such as bronchitis or whooping cough. In the multiparous woman, any heavy lifting or laborious occupation must play its part in the production of these hernia.

As regards the symptoms caused by these hernia, they will mainly depend on the age of the patient. In young children the ovary appears as a hard rounded swelling which is freely movable and is not tender. It may lie in the inguinal canal, at the external abdominal ring, or actually in the labium majus. In adult women the symptoms are more definite. The ovary is frequently hypersensitive and often painful on palpation. There is usually a history of enlargement of the ovary at each menstrual period, this swelling may be painless or on the other hand it may be so painful that it prevents the patient from walking about. If a rectal or vaginal examination is made in these cases the uterus will be found to be displaced to the side of the hernia. The complications which may arise in hernia of the ovary and tube are not numerous by far the most frequent being torsion and strangulation. In young children torsion is fairly common, and if it is long continued it may result in strangulation. A case has been reported by Eustace and McNealy of strangulation of the ovary and tube in an infant 6 months old.

The only effective form of treatment is operation, treatment by trusses very rarely, if ever, effecting a cure. There is a very real danger of atrophy of the ovary and cystic or degenerative changes may result owing to the pressure of the truss. The operation is very easy, and the

## SUMMARY OF TWENTY FIVE CASES OPERATED UPON AT KING'S COLLEGE HOSPITAL AND BELGRAVE HOSPITAL FOR CHILDREN

No	Name	Age in years	Date of admission	Condition	Date of operation	Contents of hernial sac	Treatment adopted	Date of discharge	Remarks
1	D M	1 <sup>1</sup> / <sub>11</sub>	3-11-19	Right inguinal hernia	3-12-19	Ovary and fallopian tube	Replaced inside abdomen	3-23-19	
2	L V P	4	5-29-19	Right inguinal hernia	5-30-19	Ovary and fallopian tube	Replaced	6-10-19	
3	S P	4 <sup>1</sup> / <sub>12</sub>	6-16-19	Left inguinal hernia	6-18-19	Ovary and fallopian tube	Replaced	6-28-19	
4	D G	5	1-14-20	Left inguinal hernia	1-15-20	Ovary and fallopian tube	Replaced	1-24-20	
5	D E F	2 <sup>1</sup> / <sub>12</sub>	3-23-20	Right inguinal hernia	3-24-20	Ovary and fallopian tube	Replaced	4-3-20	
6	A P	1 <sup>1</sup> / <sub>11</sub>	4-19-20	Right inguinal hernia	4-20-20	Ovary and fallopian tube	Replaced	4-29-20	
7	L F	9 <sup>1</sup> / <sub>11</sub>	2-2-21	Right inguinal hernia	2-4-21	Ovary and fallopian tube	Replaced	2-14-21	
8	H A T	1 <sup>1</sup> / <sub>11</sub>	3-5-21	Right femoral hernia	3-5-21	Ovary fallopian tube and omentum	Ovary and tube excised	3-20-21	Strangulated ovary and tube Ovary so engorged that it was four times its natural size
9	W L F	2	7-15-21	Left inguinal hernia	7-22-21	Ovary and fallopian tube	Replaced	8-4-21	
10	T H	2	5-7-22	Right inguinal hernia	5-9-22	Ovary and fallopian tube	Replaced	5-25-22	
11	J S	4 <sup>1</sup> / <sub>12</sub>	5-24-22	Right inguinal hernia	6-3-22	Ovary and fallopian tube	Replaced	6-15-22	
12	M A	9 <sup>1</sup> / <sub>11</sub>	5-6-23	Right inguinal hernia	5-7-23	Ovary and fallopian tube	Replaced	5-21-23	
13	B A G	3	1-26-24	Right inguinal hernia	2-27-24	Ovary and fallopian tube	Replaced	3-12-24	
14	A K B	47	4-5-24	Right inguinal hernia	4-7-24	Ovary and fallopian tube	Replaced	4-26-24	
15	R R	1 <sup>1</sup> / <sub>11</sub>	5-30-24	Left inguinal hernia	6-4-24	Ovary and fallopian tube	Replaced	7-29-24	
16	D A D	8	9-8-24	Right inguinal hernia	9-8-24	Ovary and fallopian tube	Ovary removed	9-20-24	Acute torsion of ovary
17	J K	3 <sup>1</sup> / <sub>11</sub>	12-15-25	Left inguinal hernia	12-16-25	Ovary and fallopian tube	Replaced	12-29-25	
18	A T	45	6-11-26	Right inguinal hernia	6-18-26	Ovary and fallopian tube	Replaced	7-2-26	
19	S S	35	6-11-26	Left femoral hernia	6-18-26	Ovary	Ovary removed	7-2-26	Ovary was adherent to the sac wall and very fibrosed
20	E W	29	4-21-27	Left inguinal hernia	4-29-27	Ovary and fallopian tube	Replaced	5-10-27	Patient was 3 months pregnant
21	A D	53	5-17-27	Strangulated right inguinal hernia	5-17-27	Loop of small intestine ovary and tube	Ovary removed	6-8-27	Acute torsion of ovary
22	K M	56	8-3-27	Double femoral hernia	8-5-27	Ovary tube and omentum in sac on right side	Ovary removed	8-24-27	Ovary was adherent to sac wall and very fibrosed
23	H L	55	2-10-28	Right inguinal hernia	2-12-28	Ovary and fallopian tube	Ovary removed	2-28-28	Ovary twisted and adherent to sac wall
24	A E	1 <sup>1</sup> / <sub>11</sub>	5-3-28	Right inguinal hernia	5-5-28	Ovary and fallopian tube	Replaced	5-20-28	
25	G B	1 <sup>11</sup> / <sub>12</sub>	8-23-28	Left inguinal hernia	8-24-28	Ovary tube and uterus	Ovary removed Tube and uterus replaced	9-6-28	

mortality exceptionally low. The ovary and tube can be returned to the abdomen and the hernial sac excised. Where torsion or strangulation have occurred, however, excision should be performed, as a useless fibrotic ovary always results from these complications.

The 25 cases tabulated have occurred in a series of inguinal and femoral hernia in females who have been operated upon at King's College Hospital and the Belgrave Hospital for Children in London during the years 1919-1929. I wish to thank my surgical colleagues attached to these hospitals for allowing me to make use of their notes on the cases. In this series there were

300 cases of inguinal hernia and 200 cases of femoral hernia. Of the femoral cases 196 occurred at King's College Hospital and 4 only at the Belgrave Hospital for Children. Femoral hernia in children must be looked upon as a very rare condition, and, according to Rutherford, occurs in about 0.4 per cent of the cases which have been recorded.

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## RUPTURE OF THE SPLEEN

### A REPORT OF TWENTY SEVEN CASES

LEO DRETZKA, M.D., F.A.C.S., DETROIT, MICHIGAN

**ALTHOUGH** the spleen lies hidden in a protected recess, it is frequently lacerated, macerated, and perforated by crushing injuries, bullets, and stabs. Its vascularity is so extensive that injuries to it result in a high mortality rate. Associated trauma is not infrequent, especially in this case in bullet wounds.

Connors reviews a series of 39 cases, which came under his observation at the Harlem Hospital in New York. In his group, the great est number of cases were due to automobile accidents, while the majority in the writer's series were caused by gunshot wounds.

The present collected group were operated upon in the City of Detroit Receiving Hospital. The predominating factor causing the injury was the bullet. Of 27 cases operated upon, 14 were gunshot wounds, 9 the result of automobile accidents, 2 were caused by falls, and 2 were stab injuries. Of this group, 17 lived and 10 died. Eight of the 10 fatal cases were complicated by extensive injuries to organs other than the spleen (Table I).

The majority of patients were adults, all in the active period of life. The youngest victim was 11 years and was struck by an automobile. The oldest was 42 years. The adult age range was from 21 to 42 years. Of the total number, 7 were females. Industry did not contribute to the fatalities to any extent. The majority of injuries were the result of social warfare and traffic.

#### SYMPTOMS AND SIGNS

Evidence of profound systemic shock is present in the majority of cases, the degree depending on the extent of the laceration with its resultant hemorrhage and the involvement of neighboring organs. If the symptoms are more or less mild, it may be assumed that the injury produced only a subcapsular hematoma or slight rent in the capsule. That this is not an infrequent lesion is evidenced by postmortem findings of this nature in 3 cases, not in this series, where the fatal lesion was brain laceration and skull fracture. The bleeding from the slight laceration of the spleen was controlled by clotted blood and had these cases been free from complications, surgical interference would not have been warranted.

The symptoms are usually those of severe intra-abdominal hemorrhage. The face is pale and pinched in appearance. The lips are dry and beads of perspiration are present on the skin. The pulse is rapid, weak, and thready. Rigidity is usually general but may be confined to the upper left hypochondrium. Localization of pain in this region is an important symptom, as perforation of the spleen, kidney, or liver produces more severe pain than does a similar injury to the hollow viscus. The symptom of referred pain is of little value, since the victim is frequently in a confused, shocked mental state. Dullness on percussion in the left flank is an important symptom. There was no case of unconsciousness in the pres-

ent group. Four were described as semiconscious, which can be readily attributed to profound shock. Low systolic blood pressure is a common finding and a valuable guide in determining the time of operation. Abdominal rigidity and pain to a greater or lesser degree were present in all of the patients. In the majority, these symptoms were localized in the left hypochondrium. Nausea and vomiting are not uncommon symptoms. Keen observation of vague symptoms is imperative in all types of abdominal injury. The following case well illustrates a spleen rupture in an unsuspected case.

R. L., aged 17 years, fainted on the street and was brought to the hospital. Four days previous to admission, he fell against a wire fence injuring the left side of his abdomen. He was taken to a private hospital for examination and immediately discharged with a diagnosis of minor injury. He returned to work the following day, but was weak and faint. His parents noticed his palor and general debility. As stated, he was brought to the hospital 4 days after injury. Operation disclosed massive blood clots in the abdomen. There was a large laceration on the left lobe of the liver and a laceration of the upper pole of the spleen. Stimulation, blood transfusion, and other postoperative measures failed, and the patient expired. It is reasonable to believe that death was due to the failure of early diagnosis.

#### DIAGNOSIS

History of an injury, and most frequently an external wound in the upper left hypochondrium, together with symptoms of internal hemorrhage, leaves little doubt as to the diagnosis. Intra-abdominal trauma with hemorrhage makes an exploratory laparotomy imperative, and the surgeon must be prepared for any emergency. When the site of a blow is localized in the left upper quadrant of the abdomen, the liver may be free from injury, but in gunshot wounds that organ is frequently involved together with the spleen. Trauma to the hollow viscus gives rise to a more generalized rigidity and the accompanying pain is less profound. Vomiting is present more often in intestinal and stomach perforation than in laceration of the spleen, its diagnostic value is doubtful except that it indicates intra-abdominal trauma.

#### SURGICAL PATHOLOGY

The effects of splenectomy, both in man and animals, seem to indicate that the function of the spleen is assumed by the remaining reticulo-endothelial system. It is regrettable that it is so difficult to follow up our traumatic cases, for here we remove apparently a normal organ (though injured) from an essentially normal individual. Mayo and Archibald state "In accidents where the spleen is ruptured, it will very often be found that a pathological condition existed previously

and resulted in enlargement and friability of the organ." This is contrary to the findings in the present series, where none of the injured spleens was grossly pathological, and the specimens removed disclosed no microscopic pathology indicating disease.

Boyd observes "The red cells of the blood are diminished in number, but seldom below 3,000,000, and the anemia disappears by the end of 2 months. A leucocytosis, due mainly to an increase in the number of the polymorphonuclears, persists for about 4 months. A rise to over 30,000 occurs shortly after the operation, but in a few days' time it drops to 20,000." In the present series, the admission blood examination was omitted in the majority of the cases. The post-operative cystology shows an increase in polymorphonuclear leucocytes and a decrease in haemoglobin and red cells. The white cell count ranges from 8,250 to 42,000 white blood cells. There were urinary complications in 6 cases, and in 3 a positive blood Wassermann.

Trauma caused by gunshot or stab wounds is usually not so destructive to the organ as are crushing accidental injuries. The circumscribed wound in the spleen, therefore, frequently permits the use of the tampon or suture, whereas, a crushing injury causes extensive laceration and demands a splenectomy. The least protected lower portion of the organ is most frequently affected. Although all degrees of wounds are encountered, as perforating, gutter, lacerating, and macerating, bullet wounds involve neighboring organs more constantly than does trauma of other varieties. As in Case D 671, a gunshot wound in the left eighth interspace caused a perforation of the spleen, stomach, and liver.

#### TREATMENT

The two factors to be placed in the balance when confronted with a case of intra-abdominal hemorrhage are the patient's resistance to additional operative trauma, and the knowledge that delay beyond a certain point is fatal. To operate on a patient suffering with systemic shock is unpardonable. The victim should be removed to a warm bed and every means at the surgeon's disposal used to stimulate the depleted system and re-establish the blood pressure. Intravenous injections of saline and glucose are immediately available, while these aids are effected, preparations for a direct transfusion of blood are made. The transfusion is best given without removing the patient to an operating room. Auto-transfusion of abdominal blood is possible in selected cases, provided the surgeon is positive

TABLE I.—TABULATION OF CASES—NINE YEAR PERIOD

Case	Age	Sex	Type of injury	Prominent admission symptoms	Operative findings	Treatment	Lived	Died	Stay in hospital
B3778	22	M	Automobile accident	Pain rigid abdomen shock	Extensive laceration of spleen	Mattress suture	Yes		20 days
51	25	F	Thrown against curb	Severe pain contusion of left chest, fracture 8th and 10th ribs	Laceration of spleen	Splenectomy	Yes		22 days
C11713	20	M	Gunshot wound abdomen and left arm	Rigidity nausea and pain	Perforation of lower angle of spleen	Suture and pack	Yes		10 days
C11984	19	F	Automobile accident	Pain vomiting rigidity distention	Transfusion lost most from rupture of spleen Rupture right and left kidney	Lost most from		Yes	6 hours
C17021	33	M	Stab wound in left back	Several body wounds vomiting rigidity alcoholism	Fracture wound of spleen	Mattress suture	Yes		17 days
52	39	M	Fall in suicide attempt	Body contusions shock no rigidity, fractured arm	Maceration of spleen Free blood clots	Splenectomy	Yes		29 days
53	40	M	Gunshot wound in left left rib margin	Localized rigidity nausea shock	Puncture wound of spleen Some free blood	Gauze pack	Yes		12 days
54	31	M	Stab wound left back	Rigidity abdominal distention vomiting	Laceration of spleen perforation of stomach	Gauze pack and suture		Yes	3 days
F18841	31	F	Gunshot wound in abdomen	Shock pain nausea rigidity	Several perforations of small bowel, omentum perforation of spleen	Gauze pack in perforation		Yes	1 day
L17037	26	M	Stab wound eighth interspace	Shock pain rigidity alcoholism	Laceration of spleen and puncture of duodenum	Splenectomy	Yes		10 days
13307	42	M	Gunshot wound right arm chest abdomen	Alcoholic stupor shock rigidity	Laceration of liver perforation of spleen	Gauze pack and mattress suture of liver		Yes	4 days
B2593	23	M	Gunshot wound of chest, ninth interspace	Mild shock no rigidity severe pain	Perforation in lower margin of spleen Free blood	Gauze pack	Yes		14 days
17071	26	F	Suicide attempt Gunshot wound left chest	Semiconscious pain slight rigidity	Perforation anterior and posterior walls of stomach Laceration of liver and laceration of spleen	Splenectomy	Yes		20 days
L13472	18	M	Gunshot wound of abdomen and right leg	Profound shock	Laceration of spleen liver, perforation anterior wall of stomach	Suture and pack		Yes	1 day
C3868	23	M	Gunshot wound in left back	Pain shock rigidity	Fracture wound of spleen	Pack	Yes		23 days
12803	38	M	Struck by automobile	Abdominal pain severe shock distention	Extensive laceration of spleen Free blood clots	Splenectomy		Yes	3 days
127784	26	F	Struck by automobile	Shock rigidity upper left quadrant nausea no distention	Several lacerations of spleen	Splenectomy	Yes		28 days
128046	21	M	Fall into pit	Confused mentally severe pain no rigidity	Extensive rupture of spleen free blood and clots	Splenectomy	Yes		14 days
F148	21	M	Gunshot wound	Shock rigidity upper quadrant hemorrhage from nose and mouth	Single perforation of spleen Perforation of liver	Gauze pack in spleen and liver Blood transfusion		Yes	21 days
L11123	17	M	Four days previous to admission fell against fence	Shock pain in upper abdomen, rigidity pain abdominal dullness	Laceration of spleen and liver Massive blood clots	Gauze pack and mattress suture Blood transfusion		Yes	3 hours
L11506	26	M	Automobile collision	Shock abdominal pain retention of urine Semi-conscious	Laceration upper and middle aspect of spleen	Gauze pack	Yes		28 days
F16087	31	M	Gunshot wound in left back	Shock semi-conscious upper abdominal rigidity pain	Double laceration of liver Laceration of spleen Massive blood clots	Suture and gauze pack		Yes	2 days
F1773	21	M	Gunshot wound axillary line curb rib	Pain rigidity shock	Severe laceration at hilus of spleen	Splenectomy		Yes	2 days
F18841	40	M	Gunshot wound of back tenth interspace	Shock pain rigidity upper left quadrant	Laceration of spleen	Gauze pack	Yes		21 days
13413	38	F	Gunshot wound left upper quadrant	Rigidity pain mental confusion	Laceration at hilus of spleen Free blood	Splenectomy	Yes		21 days
B11223	39	M	Gunshot wound left abdomen and left forearm	Pain shock, upper abdominal rigidity	Laceration lower angle of spleen	Suture and pack	Yes		21 days
C116561	27	M	Stab wound left upper quadrant with herniation of omentum	Pain not in shock rigidity localized	Two puncture wounds of spleen active bleeding and free blood in abdomen	Suture	Yes		21 days

TABLE II—RECOVERED CASES—INTERVAL BETWEEN ADMISSION AND OPERATION

	Cases
Less than 1 hour	2
Less than 2 hours	4
Less than 3 hours	2
Less than 5 hours	5
Less than 6 hours	1
Less than 7 hours	3
	17

that it is not contaminated by a perforation from the hollow viscus. This method has, however, not been resorted to in this series. When the patient has reacted sufficiently to warrant interference, the operation may be done. Delay in the operating room is a serious factor, and all details need to be arranged before the patient is removed from his heated bed.

Spinal anesthesia should be used if possible. It produces more complete relaxation and exploration can be carried out more thoroughly. The possible fall in blood pressure sometimes acts as an aid in controlling massive hemorrhage.

The operation must be performed quickly and as gently as possible. Exposed viscera should be covered with warm sterile pads and replaced in the abdominal cavity without delay. A splenectomy or suture of the organ cannot be done unless the incision is ample. A long incision at the beginning of an operation will often save the surgeon much distress. A rent in the capsule may be conveniently treated by a mattress suture, and this is also true of a puncture or stab wound. Catgut is preferable to the non-absorbable material. The suture must be inserted with gentleness and tied with caution. No case of secondary hemorrhage was encountered in this series, although this complication is conceivable in the group of tamponed cases. Injuries to the vessels near or at the hilum cause massive hemorrhage and immediate sple-

TABLE III—FATAL CASES—INTERVAL BETWEEN ADMISSION AND OPERATION

	Cases
Less than 1 hour	7
Less than 2 hours	2
Less than 5 hours	1
	10

TABLE IV—OPERATIVE PROCEDURES

	Lived	Died
Splenectomy	7	2
Suture	3	
Suture and pack	2	5
Pack	5	2

nectomy is indicated rather than suture or tampon. Extensive laceration and maceration of the organ should also be treated by splenectomy.

After the troublesome hemorrhage has been controlled, a minute inspection must be made of the neighboring organs. If the surgeon is satisfied that the viscera are undamaged, then the wound is closed without drainage.

Postoperative stimulation is essential. Infusion of saline and glucose was given in every case and if necessary, direct transfusion of blood should be repeated after the patient has been returned to his bed.

#### CONCLUSIONS

1. Splenectomy is superior to suture or tampon when the laceration or maceration is extensive or if the lesion involves the hilum of the spleen.
2. Suture or tampon readily controls bleeding in the majority of the stab or bullet wounds.
3. Secondary hemorrhage has not been encountered in this series.
4. The pre-operative treatment of shock is essential.
5. Complications are frequent and account for the high mortality rate in this type of injury.

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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### AGAIN THE CANCER PROBLEM

THE recent use of an extract of supratrenal cortex, in combating cancer, has received such wide publicity as again to attract general attention to the cancer problem. The question arises what can we tell the laity about cancer?

First, it can be said that cancer never develops in sound tissues, and this knowledge is manifested in the understanding of physicians of the danger of permitting sources of chronic irritation to continue. Second, in the early stages of malignant change surgical removal of the growth or, in suitable cases, the use of radiotherapy gives a high percentage of cures.

It is difficult, however, for the laity to appreciate to what extent cure is possible in cancer, and in their very fear of a condition which they believe to be hopeless they often delay surgical consultation. This widespread pessimism exists because when death occurs from cancer, the cause of death cannot be concealed, whereas persons who have been operated on successfully for cancer hide the fact that they have had malignant disease because general knowledge of it would stand in

the way of their future advancement. As a consequence the public has known much of the horrors of the disease and little of its curability.

The close relation of chronic irritation to cancer of the visible surfaces of the body cannot be controverted. For instance, cancer of the scalp is common among the Chinese, who shave the head with dull and rough edged instruments, and is uncommon among peoples who do not have this practice. In China the men eat at the first table, when the rice is hot, and their practice of throwing the rice by means of chopsticks with considerable force into the posterior part of the pharynx and the first portion of the esophagus, results frequently in cancer in this situation. The Chinese women, who eat at the second table when the rice is cold, do not often so suffer.

A form of cancer of the mucous membrane of the mouth which is common in the Philippines and in parts of India, is the result of chewing the betel nut, which, wrapped in its leaf with lime, is carried almost constantly in the cheek. Note the great reduction in cancer of the mouth and about the gums as the result of good dentistry, and in cancer of the lip with the disappearance of the clay pipe. It is said that cancer of the breast, so common in civilized women, has no corresponding frequency in women of those races who leave the breasts exposed. In the mountains of Kashmir, where the natives carry charcoal braziers filled with hot coals strapped to the lower abdomen, cancer of the skin just above the pubes is common.

The relation of chronic irritation to cancer of the external surfaces of the body is paral-

leled by cancers of the internal surfaces, but the evidence is necessarily indirect

Cancer of the gall bladder is seldom seen except in connection with gall stones, and even those investigators who do not believe that cancer of the stomach often has its origin in ulcer, admit that cancer on ulcer does occur in a percentage of cases which Hurst, of Guy's Hospital, London, puts at about 20 per cent. In our own experience, while the percentage in which the histological examination of excised cancers of the stomach for evidence of preceding ulcer varies in different series of cases, the development of gastric cancer on some type of demonstrable precancerous disease, such as ulcer, is present in more than 25 per cent. When cancer of the mesoblastic structures occurs, the preceding source of chronic irritation is probably biochemical in nature

When we attempt to explain what happens in chronic irritation in relation to cancer, there are two outstanding points of view

First, it is believed that some micro-organism or other outside agent enters the body and gives rise to cancerous growth. However, if this were true, secondary cancers would show the histopathological characteristics of the organ in which they occurred, whereas they show those of the original lesion. For instance, if a cancer originating as an adenocarcinoma of the mucous membrane of the stomach extends to the liver by metastasis, the new-growth proves to be not a cancer of the liver, but a cancer of the mucous membrane of the stomach in the liver, proving that the malignant cell itself has been transplanted to the liver, and is itself parasitic

Second, it is equally probable that when a breach of continuity in the tissues occurs as the result of long-continued chronic irritation, the attempt is made first to heal the defect with normal cells, but in the course of time,

as the reparative processes are exhausted, cells less and less mature are thrown into the breach, until finally embryonic cells, but the best that can be supplied, replace the normal epithelium and take on malignant change

This brings up an interesting side line of thought, and that is that the age of cells and their condition must play a prominent part in the development of malignant disease. Perhaps the reason cancer usually appears after middle age is that the cells of the body have lost the reparative power of youth, have a lessened immunity, and thereby have become more vulnerable. Again those organs of the body which have a relatively short heredity are more often involved than organs which we know to be more primitive and which might be said thereby to have gained hereditary resistance to the disease

In this connection, the frequency of cancer of the stomach and of the large intestine and rectum, what might be called modern organs of convenience, as contrasted with the infrequency of cancer of the more primitive small intestine with its ancient heredity, is suggestive. Malignant disease of the testis, which is the primitive organ, is rare as contrasted with the many varieties of malignant disease of the ovary, a relatively recent organ derived from the primitive testicle. One can carry such a theory still further and point out the great incidence of cancer of the breast and the uterus in women at the menopause, whereas in men there is no such frequency of cancer in the generative organs, because no comparable senile change takes place

If we attempt to visualize the problem of cancer, therefore, certain factors must be borne in mind. The age and the condition of the bodily cells, especially those cells that have a protective function, must be considered. Again, those organs of the body, the breast and the uterus, which undergo early senility,



carry with them an increasing risk of cancer, and finally, the only reasonable explanation why 90 per cent of persons do not have cancer and why 10 per cent do have cancer is that there is a varying degree of immunity in individuals to the cause or causes of cancer, which leads to the hope that resistance to this disease may be increased as it has been in other diseases of man

W J MAIO

## POSTOPERATIVE PULMONARY COMPLICATIONS

ONE result of the researches conducted on the important question of etiology of postoperative pulmonary complications has been the development of two schools whose members explain the phenomena along widely divergent lines. In the case of the aspiration hypothesis, there has been much carefully conducted experimentation presenting the evidence quite logically, and an equal amount, fully as scientifically supervised, apparently proving beyond cavil that acute pulmonary lesions following surgical operations are purely embolic in origin. A third school, of more recent origin, emphasizes the frequency of massive or lobular atelectasis resulting from bronchial obstruction.

Cutler concludes that pulmonary abscesses result most commonly from infected emboli, that, only with difficulty, can abscess be produced in the experimental animal by the insufflation and aspiration of anaerobic or aerobic organisms, and that aspiration of buccal contents is a usual occurrence in patients submitted to general anesthesia. The same conclusions are reached by Van Allen, Adams, and Hrdina. From an experimental study conducted recently by Holman and Mathes, it was found that emboli must be *infected* to produce marked pathological changes in the lung—that sterile emboli produce but little

gross evidence of their presence. Flick, in a clinical study of 172 cases of abscess of the lung, found that 62 per cent followed tonsillectomy and oral infections. Most writers find a high incidence of abscess following respiratory tract operations, but this is not the finding with the other and more common pulmonary complications, collapse, pneumonia, infarction, etc.

By a long continued and carefully conducted investigation, Whipple has added greatly to our knowledge of this subject and has led the school of proponents of the aspiration theory. That bronchial aspiration commonly occurs when patients are under general anesthesia and that pulmonary diseases only rarely result therefrom is, however, being frequently and consistently demonstrated. May, Thoburn, and Rosenberger have recently studied, radiographically, the aspiration of iodized oil into the bronchial tree of patients undergoing tonsillectomies and conclude that some aspiration is unavoidable in all operations requiring an inhalation anesthetic. In a series of patients studied by them, it was found that aspiration occurred in 48 per cent. Similar conclusions were reached by Myerson who, in a series of two hundred cases, reports an aspiration percentage of 75, while the *Dailys*, in their series of one hundred cases, report aspiration as occurring in 78 per cent. In one hundred bronchoscopies performed after tonsillectomy, Iglaue and his associates report aspiration of mucus or tissue particles as occurring in 40 per cent.

The recent work of Lee, Tucker, Ravdin and Pendergrass has cast much light on the question of the etiology of massive collapse and has demonstrated the rôle, possibly the leading one, of bronchial obstruction with tenacious mucus, in producing the condition. However, certain of these contentions are questioned in a subsequent study made by

Muller, Overholdt, and Pendergrass These students of the problem demonstrated that, roentgenologically and on physical examination, many patients show signs far out of proportion to the symptoms. Also, that on the first postoperative day, average pulmonary vital capacity is but 33 per cent of the pre-operative reading. It is held that hypoventilation of the lungs, especially after upper abdominal operations, is the usual state and should be regarded as normal. The follow-up of Lee, Wilmer, and Cohe in their cases of postoperative massive atelectasis has shown that these patients were asthmatic or were definitely allergic in every case. This would seem to suggest that we have another etiological factor in this phenomenon which should be carefully studied.

Foss and Kupp, studying the pulmonary complications following more than four thousand general surgical operations and four thousand operations on the nose and throat, all performed in the same hospital with same anæsthetists and paralleled operating room technique, found an incidence of 1.7 per cent on the general service, while there were no cases of pulmonary complications whatever on the nose and throat service. The incidence of pulmonary complications following spinal anæsthesia was found to be as great as with patients who were operated upon under general inhalation anæsthetics. They further conclude that their studies strengthen the theory that embolism plays the chief rôle in the production of most postoperative pulmonary complications and that (1) infarctions (minor emboli) are far more common than has been generally supposed, (2) aspiration plays but a minor rôle in the production of pulmonary complications, (3) pulmonary complications are, relatively, infinitely less common following operations on the upper respiratory tract than following operations on the abdomen and

pelvis, (4) irritation by the anæsthetic or the aspiration of foreign substances during inhalation anæsthesia probably plays a part in the production of postoperative bronchitis and pneumonia (however, the fact that these complications follow spinal and even local infiltration anæsthesia with great frequency suggests that other factors are of equal importance), (5) the incidence of post-pulmonary complication is as high following spinal anæsthesia as after general inhalation anæsthesia.

Whatever the condition, whether the aspiration pneumonia of Whipple, the embolic processes of Cutler, the atelectasis of Lee and his co-workers, or a combination of all these and others yet undiscovered, the treatment advocated in prophylaxis of massive collapse seems to apply equally well to all anticipated postoperative pulmonary complications, namely (1) hyperventilation during and after operation with carbon dioxide and oxygen, as advocated by Scott and Cutler, (2) change in the position of the patient every 6 hours, after operation (Sante), (3) curtailment of postoperative sedatives, especially those which depress the cough reflex. The use of desiccated thyroid, as recently suggested by Walters, seems completely to prevent the development of postoperative pulmonary embolism. This advice should be carried out with all cases of suspected pulmonary complications—better still, routinely, with all operative patients seriously ill. Finally, when symptoms definitely appear, there is the oxygen tent, our newest and, perhaps, most effective aid. Muller routinely places all of his patients suffering with perforated peptic ulcer in the tent—an excellent plan that might be followed with all seriously ill surgical patients who are in danger of developing respiratory complications.

HAROLD L. FOSS

# MASTER SURGEONS OF AMERICA

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## JOHN T. BOTTOMLEY

A BRIEF review of the life and surgical career of the late Dr. John T. Bottomley of Boston, Massachusetts, will make evident the fact that in his sudden death in December, 1925, at the age of 56, in the full tide of his activities, the surgical profession of this country lost one of its leaders and New England one of its most valued and popular consultants. He was born in Lee, Massachusetts, on September 24, 1869. He graduated from Holy Cross College in 1889 and from the Harvard Medical School in 1894. In school he was an enthusiastic and intelligent student, and stood near the head of his class. He then went to work as interne at the Boston City Hospital, where the writer first knew him. His efficiency, ability, and the cheerfulness with which he went at his work endeared him to the staff and to his patients. He was honest, kindly, sympathetic, and resourceful. He just could not do enough in his efforts to relieve suffering. During the Spanish American war he was assistant surgeon to the late Dr. H. L. Burrell on the Hospital Ship Bay State. Well or seasick, he was the same cheerful, willing worker and exerted himself to the utmost in the cure of the typhoid and tropical diseases which characterized that war.

In 1897 he began practice in Boston and soon (in 1899) was appointed to the staff of the Boston City Hospital. He was made supervising surgeon to the Relief Station in Haymarket Square, where he made a name for himself in major traumatic surgery. At the City Hospital he made a special study of the relief of distention and tympanites after laparotomy, and added real contributions to the treatment of these cases.

In 1902 he went with Dr. John C. Munro to the Carney Hospital, one of the hospitals of the Sisters of Charity. There these two men did pioneer work, especially in placing on a firm basis the surgery of ulcer and cancer of the stomach. Also, in the subject of the surgery of the gall bladder, they contributed much. Together these two men built up an active and progressive clinic, where the work attracted frequent visits from the surgical societies of the country, as well as visits of individual leaders in our art. On the death of Dr. Munro in 1910, Dr. Bottomley succeeded to his position and carried on the work with undiminished energy. His loyalty to his chief was a fine feature of their association. He was in great demand as a consultant throughout New England and was consult-



JOHN T. BOTTOMLEY  
1869-1925



ing surgeon to twelve hospitals. He gave freely of his time and strength and made a reputation not only for surgical skill, but for wisdom, honesty, and kindness. He never spared himself, and when not with his work at the Carney was constantly on the move over New England.

He always took time to visit the great clinics of the country and was a member of the Society of Clinical Surgery and of the American Surgical Association, where his cheerfulness and sunny disposition won him many friendships, which were both strong and lasting. He surely was the prince of good comrades. To the scientific proceedings of these societies he made many valuable contributions, which were characterized chiefly by sanity and good sense. He loved books and art and had a wonderful collection of old medical prints, as well as rare old books, both in medicine and general literature.

During the World War he was a captain in the medical corps and used his good judgment efficiently in the examination of candidates for the medical service. He also served as advisor to the draft boards. In this work, as with everything that he did, he spared no expenditure of time and strength.

He was a member of the Roman Catholic Church and, wherever he might be, never neglected his religious duties. The eulogy at his funeral by Monsignor Splaine was one of the finest tributes ever paid to a member of our profession. In his family life he was most happy. In 1908 he married Mary Agnes Kenney, of Boston, who with five children—three sons and two daughters—survives him. About two years before his death he suffered from an infected finger, associated with a septicæmia, which affected his heart and kept him away from his practice for several months. Then he went to work again, but was obliged to limit his activities in some degree, although the demands upon him were constant. He had operated at two hospitals on the morning of the day he died. Death came to him instantly and painlessly. His many patients, friends, and his fellow surgeons all over this country will not soon forget his, strong, cheerful, smiling, competent John Bottomley.

FRED B LUND

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D. F.A.C.S., OMAHA, NEBRASKA

### THE COLLECTED WORKS OF JEROME CAPIVACCUS

IT is interesting to note what one of these so called educated internists of the sixteenth century had to say regarding surgery as it applied to his field of internal medicine. Hieronymus Capivaccus or Jerome Capivaccio was born at Padua during the early part of the sixteenth century. Unlike the majority of the medical men of his time he did not travel around from place to place but contented himself with remaining in his native city where he took his medical education at the University of Padua. Presumably following the receipt of his doctor's degree he continued to work at the university, for in 1552 he was given a subordinate professorial position in the medical department, and in 1564 was appointed the regular professor of medicine in the university. He was a man of great learning. He knew the ancient languages and his knowledge of the works of his predecessors in medicine was considerable. He attained a wide reputation, and in 1587 was called by the Grand Duke of Tuscany to the chair of medicine at the University of Pisa, but this he declined in order to stay in Padua and there he remained in his native town until his death in 1589. He was particularly interested in the treatment of syphilis and tells us at the end of his chapter on the treatment of that disease that he made over 18,000 ducats in the treatment of this ailment alone. It is rather worthy of note that he mentions as the surgical treatment of this disease, the ever present phlebotomy and also the use of the cautery on venereal ulcers and other skin lesions.

Capivaccus' work was practically all published after his death. According to the bibliography, as given by Gurli, the first work to appear under his name was on *Lues Venerea*. This appeared in 1590. When the first edition of his entire work was printed I am unable to state. The edition here illustrated was printed in 1601 and is stated to be the third edition of the work. It contains all of the individual works of Capivaccus which had been published up to that time in one large folio volume. It is devoted almost entirely to internal medicine, but in the discussion of the cure of the various diseases there is usually an article devoted to the surgical treatment. This is nearly always nothing more or less than the indication for phlebotomy in the disease accompanied by directions as to where the blood should be drawn and how much blood should be

taken. Throughout the entire work Capivaccus constantly refers to Galen and the Arabian physicians and seems to take them as the last word regarding both diagnosis and treatment. Here and there however he refers to surgical methods aside from venesection, non-operative it is true, but at the same time interesting. For example, in his discussion of angina, which he describes as an inflammation of the throat and upper portion of the pharynx he tells of the method of passing a tube into the stomach in order to introduce food when swallowing becomes extremely difficult. He says however that this may irritate the parts and make swallowing still more difficult. He suggests the passage of a tube down to the beginning of the oesophagus. He then places at the proximal end of the tube a clean animal bladder which he has filled with liquid nourishment and by squeezing on the bladder squirts it into the oesophagus and so into the stomach. In stricture of the oesophagus he writes as follows: "Therefore as to the surgical treatment. If deglutition is difficult and medicines are not able to diminish the difficulty it is necessary to pass waxed candles into the oesophagus and by the benefits of these many are restored to health. Aetius says if the difficulty is from paralysis it is necessary to affix cups to the chin." Apparently by his candles or wax bougies he dilates the stricture.

In the third chapter of the third book which is entitled "Concerning Diseases of the Stomach," he gives his general idea as to the field of surgery in the treatment of disease. He speaks of surgical method being divided into two parts, either bloody or non-bloody. In the bloody method he includes the uses of venesection, leeches, and cups. He then goes on and gives Galen's ideas as to the use of incision in abscesses of different parts of the body and includes this in the non-bloody classification. He states that it is the wisest thing to wait until the pus can be seen beneath the skin before the incision, which should be over the most prominent part, is made. In the eighteenth chapter of the third book under the heading of diseases of the liver, in which he takes up ascites and anasarca, he advises the various types of puncture which were current at the time. In ascites he advises puncture beneath the umbilicus into the abdomen and the withdrawal of the fluid, and in general anasarca, in which the thighs are swollen and in some cases the scrotum, he advises making incisions in the skin to allow the serum to drain out.

# HIERONYMI CAPIVACCEI

PATAVINI,

MEDICI, AC PHILOSOPHI  
PRAECLARISSIMI

Id Patauino Gymnasio Praxim admirabili cum laude publicè professi.

MEDICINA PRACTICA SIVE METHODVS COGNOSCENDORVM,  
& curandorum morborum corporis humani affectuum.

*Nunc deus edit. Et in malis vestra gerentes. Aetheris lessumus, Et partem curae  
ferre aduclit, atque omni diligencia obsequat.*

Cui adiecta sunt & reliqua quae adhuc extant, eiusdem Excellentissimi Viri

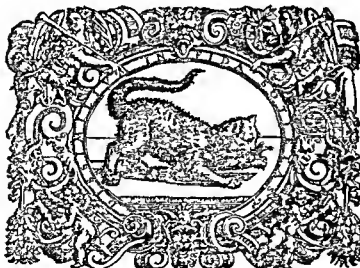
## OPERA OMNIA

Quae postrema haecensis Editione doctissimi Traductores; Altero quidem DE FOETVS FORMA-  
TIONE reliqua vero de PVLSIBVS, ac non EXPOSITIONE in Primam librum  
Aphorismorum Hippocratis & de ARTE COLLEGIANDI & MODD  
INTERDYGANDI AGROS complectitur haec,

INDVSTRIA, ac Labore SONCII LEONIS Tergestini Medici Physici

Accesserunt Index tam Librorum, & capitulorum, & rerum, & rerum complectens

CVM PRIVILEGIIS.



V E N E T I I S . M D C I

Apud Haeredes Melchioris Seffer.





## REVIEWS OF NEW BOOKS

IN a volume of 392 pages, Bourne and Stone<sup>1</sup> have attempted "to collect what are accepted as the most constant clinical pathological findings in disease, to state when the result of a test whether positive or negative is of value, and to record when such a test is worth doing and when it is incapable of giving help." This is, therefore, something of a new departure in medical books. It is concerned with the "no man's land" between textbooks of clinical pathology which are likely to be filled with minutiae of technique and textbooks of medicine which cannot afford to emphasize the interpretation of clinical pathological findings without losing balance or becoming unduly bulky. The subject matter of most of the chapters has been arranged in a uniform manner. Under the heading "General Considerations" has been gathered sufficient of the facts concerning the pathology of the disease to render the origin of the clinical pathological findings understandable. The chief of these findings are then enumerated. Finally, the bearing of each individual result of laboratory tests upon diagnosis, prognosis, and treatment is discussed. "No medical man should ask for a special investigation without knowing to what extent a positive, a negative, or an equivocal answer will react upon his clinical conception of the case." If all clinicians would observe this principle both they and laboratory workers would be saved much trouble and confusion. The contents of this book have been chosen to assist the clinician in using such knowledge and in observing this principle. This volume should prove eminently useful to internists, surgeons, and clinical pathologists. J P SIMONDS

IN past decades when careful laboratory pre-operative diagnosis was the exception rather than the rule, among the disasters encountered, and such disasters still occur, was that of failing to recognize a diabetic. The diabetic develops the same surgical lesions as the normal individual, he is particularly susceptible to one group, namely, infection and gangrene. The key to successful surgery in diabetics is the control of sugar metabolism.

The first part of *Diabetic Surgery*<sup>2</sup> is devoted to the study of the incidents of diabetic surgery, the risks of such surgery, the medical problems of insulin and diet, and anaesthesia. The second half is devoted to gangrene of the extremities, carbuncles and other skin infections, abdominal surgery, hyperthyroidism, and malignancy.

The general survey of the chemistry and dietary control, while brief, is intelligent and ample from a

surgical standpoint. The surgeon who routinely does a thigh amputation for every case of toe gangrene in diabetes, may well profit by the chapter on gangrene of the lower extremities.

The authors have not made the mistake of writing either a complete monograph on diabetes, or a voluminous surgical text. This volume will appeal to all who read it as a thorough and intelligent *arbeit*. J R BUCHENDER

THE book on *Surgical Nursing*<sup>3</sup> by Ralph Colp and Manelva Wyke Keller is a very able and interesting treatise on this important branch of medical science. The authors have given the work the stamp of actual experience. Here are found not the imaginings of an observer but the real knowledge of the worker. It carries conviction and is practical. The style is clear and unadorned but the "Introduction and History" cannot be read, even by those to whom the facts have been familiar for years, without real enjoyment and interest.

The subject matter generously includes everything which in any way is related to surgery, even a chapter on radium and X-ray. The chapter on pathology is very good but it must be borne in mind that microscopic drawings have little significance for anyone not experienced in interpreting microscopic sections. The objection is obviated somewhat by the fact that large, clear, well labelled drawings have been used. The chapters dealing with the operating room have the virtue of being practical and generally applicable, the text is splendid and one feels that the writer speaks with authority. The subject of bandaging is handled well, the illustrations are clear and simple, and the account very easy to follow. The chapter on the Carrel Dakin treatment of wounds merits special mention.

The second edition shows several changes and brings the book up to date in the light of recent developments in surgery and surgical nursing. The arrangement of the subject matter in general is better, topic heads appear in large type with adequate spacing, subtopics are in heavy type.

As a textbook for student nurses, the work has accuracy, completeness, and simplicity of style to recommend it. It should prove useful also as a book of reference for the surgical supervisor and the private duty nurse. NELLIE D MILLARD

DISEASES of the nose, throat, and ear are ably covered in the book edited by Chevalier Jackson and George Morrison Coates<sup>4</sup>. The first section

<sup>1</sup>THE PRINCIPLES OF CLINICAL PATHOLOGY IN PRACTICE: A GUIDE TO THE INTERPRETATION OF LABORATORY INVESTIGATION FOR THE USE OF THOSE ENGAGED IN THE PRACTICE OF MEDICINE. By Geoffrey Bourne M.D. (Lond.) M.R.C.P. and Kenneth Stone M.D. (Oxon.) M.R.C.P. New York and London: Oxford University Press 1929.

<sup>2</sup>DIABETIC SURGERY. By Leland S. McKinnick M.D. F.A.C.S. and Howard F. Root, M.D., with foreword by Daniel F. Jones M.D. and Elliott F. Joslin M.D. Philadelphia: Lea and Febiger 1928.

<sup>3</sup>TEXTBOOK OF SURGICAL NURSING. By Ralph Colp A.B. M.D. F.A.C.S. and Manelva Wyke Keller B.S. R.N. New York: The Macmillan Company 1929.

<sup>4</sup>THE NOSE, THROAT AND EAR AND THEIR DISEASES IN ORIGINAL CONTRIBUTIONS BY AMERICAN AND EUROPEAN AUTHORS. Edited by Chevalier Jackson M.D. Sc.D. LL.D., F.A.C.S., and George Morrison Coates A.B. M.D. F.A.C.S. Philadelphia and London: W.B. Saunders Company 1929.

of the book deals with the nose and accessory sinuses. The section on anatomy is quite extensive and illustrated with excellent cuts. The authors discuss in like manner the pharynx and nasopharynx, the ear diseases of the larynx, peroral endoscopy and finally diseases of the tracheobronchial tree.

Thirty pages of this text are devoted to the revelations of tonsilloscopy, i.e., the diagnosis of diseases of the tonsils and lymphoid structures by means of transillumination. The various instruments used are illustrated and explained. This is more or less new to include in a textbook although tonsilloscopy was described some years ago. Its value is still open to discussion.

One is impressed by the clearness of the section devoted to the inner ear and labyrinth. Here is set down in clear concise form the mechanism of normal and abnormal nystagmus with its clinical interpretation. The author has gone to extremes to make it practical and understandable. This may also be said of the chapter on intracranial complications of otitis media. Differential tables of meningitis, sinus thrombosis, and brain abscess are given. Every known means or method used in arriving at a definite diagnosis is discussed.

A major portion of the work on the larynx is contributed by such an eminent authority as Chevalier Jackson. Most of the illustrations are drawn from life by the author. A full description of the technique of peroral endoscopy is given by the same author and his co-workers. The text is printed on good paper and the type is clear and distinct with suitable captions.

A good many of the contributions are in the form of monographs and some of them have added excellent bibliographies which would make the book desirable for the research worker as well as for the practitioner. The book is in reality an encyclopædia of diseases of the ear, nose, and throat.

JOHN F. DELPHE

AS in many other instances Friedenwald's *Pathology of the Eye* is founded on a course of lectures given to medical students and house physicians. The author has attempted to show the similarity between ocular pathology and disease of other organs emphasizing etiology and pathogenesis.

The 330 pages are divided into fifteen chapters with an appendix on microscopic technique. The work is profusely illustrated, mainly with photomicrographs from the pathological collections of the Wilmer Ophthalmological Institute and the Army Medical Museum. At the end of each chapter is a list of references covering the subject matter of that chapter.

Among the original observations and deductions unpublished elsewhere, is the discussion of subacute panophthalmitis, of ocular lesions in fetal syphilis, of cataract and glaucoma, and of retinal vascular disease. Also the results of experimental researches on the rate of secretion of the aqueous, on the patho-

genesis of wood alcohol blindness, and on the relation between cataract and vitamin deficiency are published here for the first time.

No other American author has attempted to present a book on ocular pathology, and few books have been written by the English writers. Friedenwald deserves great credit for presenting this material in such an acceptable manner. VIRGIL WESCOTT

ARTHRITIS is as old as the oldest fossil and has made miserable the life of man for as long as records are extant. Less real intensive study, however, has been directed toward the elucidation of this problem than toward many less serious and less important. Cecil<sup>1</sup> in his recent monograph on the diagnosis and treatment of arthritis presents a logical classification and a remarkably clear picture of the various arthritides. The crux of any discussion of arthritis is the differentiation of the chronic atrophic and hypertrophic types. While the clinical and pathological pictures are excellently presented by the author it is doubtful if everyone will accept in their entirety his conclusions as to the etiology of the atrophic type, which he calls the chronic infectious arthritis. While the importance of focal infection is everywhere admitted it is being pretty strongly felt that the basic causes go back to the individual constitution. It is certain however that Cecil's book simplifies the subject of arthritis in a remarkable manner, he leaves one with a very definite and workable conception not only of the present status of ideas regarding arthritis but of the problems involved and lines of investigation. Each chapter takes up a separate entity, the stress being laid on diagnosis and treatment. The book represents the work being carried on at the Cornell Clinic.

M. L. MASON

THE second edition of McPheeters' monograph on the injection treatment of varicose veins<sup>2</sup> followed the first in rapid succession indicating the great demand for knowledge on this subject. A welcome chapter has been added on the Trendelenburg test and its modifications. The author has been largely instrumental in popularizing the injection treatment in this country and gives due credit to Continental workers. Other methods of treatment, such as the radical excision and the combination of ligation with injections are not favored. While the recurrences following radical excision are discussed no statement is made regarding the end results of injection treatment.

The printing and illustrations are excellent. It is unfortunate that misspelt references, together with a certain laxity in the construction of the text, deduct somewhat from the inherent value of the material.

GEORGE DE TARANT

<sup>1</sup>OXFORD MONOGRAPHS ON DIAGNOSIS AND TREATMENT. Edited by Henry A. Christian, M.D., Sc.D., LL.D., Vol. VI.—The Diagnosis and Treatment of Arthritis. By Russell L. Cecil, M.D., Sc.D. New York: Oxford University Press, 1929.

<sup>2</sup>VARIKOSE VEINS WITH SPECIAL REFERENCE TO THE INJECTION TREATMENT. By H. D. McPheeters, M.D., F.A.C.S. Philadelphia: J. A. Davis Company, 1930.

<sup>3</sup>THE PATHOLOGY OF THE EYE. By Jonas Friedenwald, A.M., M.D., F.A.C.S. New York: The Macmillan Company, 1929.

THE recent work by Souttar<sup>1</sup> has been read with considerable interest. The author states in the preface "Surgery is essentially an Art for it demands of those who would pursue it a combined dexterity of hand and eye, and an instinctive perceptiveness of values, which are the characteristics of the true artist. Yet its practice rests upon a mass of knowledge, the accumulated experience of generations, which is apt to overwhelm the student by its mere bulk and to obscure his vision of the whole in a mist of detail. To lighten his burden is the object of this volume, by omitting what is not essential and by describing very fully what is fundamental." This seems adequately to describe the text. In approximately 600 pages the author attempts to separate the wheat from the chaff, a task next to impossible so far as the subject of general and special surgery is concerned. So much depends upon the viewpoint and personal experiences.

The author attempts to illustrate the text to a considerable extent by thumb nail sketches and captions. There is no question but that this aids materially to clarify the text and to simplify finding captions, on the other hand much paper space is lost, thus increasing the bulk of the volume. Many beautiful full page illustrations are in color, which makes the book very attractive. The ones incorporated in this volume are unusually well done.

Souttar's work may be recommended to the college student of surgery but it must be supplemented by extensive collateral reading. JOHN A. WOLFER

A TREATISE on Stone and Calculus Disease of the Urinary Organs<sup>2</sup> has recently been published by J. Swift Joly, surgeon to St Peter's Hospital for Stone, London. The work is based on a study of some 636 cases of urinary calculi, covering the period from 1895 to 1924. It contains a history of urinary lithiasis and its treatment from the sixth century to the present time.

Probably the most valuable section of this work is that in which the various physical and chemical factors of the formation of stones are discussed. It is held that all calculi are formed of two distinct types of substances, the crystalline and the colloid. The author enters into a very scholarly and academic discussion of the chemistry and physiology of each crystalloid. The formation of calculi he contends is

based on retention of crystals as a potential nucleus in a portion of the urinary tract such as the lower kidney calyx.

It is stated that geographical distribution, climate, race, and heredity have no influence or importance in the etiology of stone. Lack of vitamins may play a rôle. The higher the standard of living the fewer the stones found.

Joly has discarded the phenolsulphonephthalein function test for indigocarmine because he is color blind and there is a leakage around catheters and he can eliminate catheterization for determining function.

The most conservative treatment of renal calculus is an early removal of the stone. He discusses at length the medical treatment of various stones and mentions many small points of surgical procedures worthy of note. The book contains many clear cut illustrations of operative procedures and pathological specimens. It embodies sane ideas and I believe it should be in the library of every urologist.

HARRY CULVER

A MEMORIAL volume,<sup>3</sup> composed of contributions by his numerous pupils, colleagues, and admirers, is a fitting and gracious compliment to the character, talent, and accomplishments of Jean Verhoogen. The occasion is Verhoogen's retirement from the University and L'hôpital Saint-Jean. According to the appended biographical sketch Verhoogen at 65 is still the uncontested peer of Belgian surgery. His most important contributions are in the field of urologic surgery. He appears to have popularized in Belgium cystoscopy, as well as the operations for the removal of the prostate and nephrectomy. He was able in 1901 to show a patient alive 9 years after a nephrectomy for renal tuberculosis. In 1909 he read a paper on total cystectomy. He was also one of the very first to perform a total gastrectomy (1898), and a lobectomy for pulmonary tuberculosis (1912). The volume contains 747 pages. The greater number of contributions have naturally come from urologists, in fact, it is a veritable textbook on urology. Among the many valuable contributions, it is pleasant to note two from American surgeons, Edward Beer and E. L. Keyes. The subject matter is quite varied and presents much of interest and value.

GEORGE HALPERIN

<sup>1</sup>THE ART OF SURGERY. By H. S. Souttar D.M. M.Ch. (Oxon.) F.R.C.S. (Eng.) New York: Paul B. Hoeber Inc. 1929.

<sup>2</sup>STONE AND CALCULUS DISEASE OF THE URINARY ORGANS. By J. Swift Joly M.D. (Dub.) F.R.C.S. (Eng.) St. Louis: The C.V. Mosby Company. 1929.

<sup>3</sup>LIVRE JUBILAIRE PUBLIÉ EN L'HONNEUR DU PROFESSEUR JEAN VERHOOGEN. Brussels 1919.

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

BOLETIN ANUAL DE LA CLINICA OBSTETRICA Universidad de Chile. Prof. Morandberg 1928 (Ano XV).

SURGICAL DIAGNOSIS. By American Authors. Edited by Evans Ambrose Graham A.B., M.D. Vols. 1 and 2. Philadelphia and London W. B. Saunders Company 1930.

APPLIED PHYSIOLOGY. By Samson Wright M.D. M.R.C.P. With Introduction by S. A. Vincent M.D. L.L.D. D.Sc. F.R.S. (Ed. & Canada). 3d ed. New York and London. Oxford University Press 1930.

RADIUM IN GENERAL PRACTICE. By A. James Larkin, B.Sc. M.D. New York. Paul B. Hoeber, Inc. 1929.

LA PRATIQUE CHIRURGICALE ILLUSTRÉE. By Victor Fauchet. Vol. IV. Paris. Gaston Doin et Cie 1930.

CLINIQUE ET THÉRAPIE CHIRURGICALE. PRATIQUE JOURNALIÈRE. By George Pascals. Paris. Gaston Doin et Cie 1930.

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OXFORD MONOGRAPHS ON DIAGNOSIS AND TREATMENT. Edited by Henry A. Christian M.D. Sc.D. L.L.D. Vol. VII.—The Diagnosis and Treatment of Variations in Blood Pressure and Nephritis. By Herman O. Mesenbier, M.D. Vol. VIII.—The Diagnosis and Treatment of Diseases of the Liver and Biliary Tract. By John Philipps M.B. Vol. IX.—The Diagnosis and Treatment of Diseases of the Blood. By Thomas Ordway M.D. and L. Whittington Gorham M.D. New York. Oxford University Press 1930.

VARIKOSE VEINEN, WITH SPECIAL REFERENCE TO THE INJECTION TREATMENT. By H. O. McPheters M.D. F.A.C.S. 2d rev. ed. Philadelphia. F. A. Davis Co. 1930.

TRAUMA, DISEASE, COMPENSATION. A HANDBOOK OF THEIR MEDICO-LEGAL RELATIONS. By A. J. Fraser M.D. Philadelphia. F. A. Davis Company 1930.

MODERN OTOTOLOGY. By Joseph Clarence Keeler M.D. F.A.C.S. Philadelphia. F. A. Davis Company 1930.

MINOR SURGERY. By Arthur E. Hertzler, M.D. and Victor I. Chesky M.D. 2d ed. St. Louis. The C. V. Mosby Company, 1930.

DIE THERAPIE AN DEN WIENER KLINIKEN. By Dr. Ernst Landesmann. 11th rev. ed. edited by Prof. Dr. Frohlich. Leipzig and Vienna. Franz Deuticke 1930.

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THE DRAMATIC IN SURGERY. By Gordon Gordon Taylor, OBE. M.A. F.R.C.S. New York. William Wood & Company 1930.

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VEIT'S HANDBUCH DER GYNAEKOLOGIE. 3d rev. enlarged ed. Edited by W. Stoekel and collaborators. First half. Vol. I. Anatomie und Diagnostik der Carcinome der Bindegewebsgeschwulste und Mischgeschwulste des Uterus der Blasenmole und des Chorionepithelioma malignum. By Otto von Franqué H. Hinselmann, and Robert Meyer. Munich. J. F. Bergmann 1930.

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O QUE TODOS DEVEM SABER DE CANCRO. Lisbon. Portuguese Institute for the Study of Cancer.

# AMERICAN COLLEGE OF SURGEONS

## THE STANDARDIZATION OF SURGICAL DRESSINGS

MALCOLM T. MacEACHERN, M.D., C.M., D.Sc. CHICAGO  
Associate Director American College of Surgeons and Director of Hospital Activities

**A**N extensive survey of the hospital field and a subsequent exhaustive study made by the Hospital Research and Information Department of the American College of Surgeons in co-operation with surgeons, hospital executives, manufacturers, and scientific laboratories, revealed such diversity of surgical dressings that it was considered advisable to undertake the standardization of these with a view to efficiency and economy. A tentative list of standardized dressings for adoption by surgeons and hospitals is presented in this report.

Early in the survey convincing evidence of the need for standardization of surgical dressings was apparent when it was found that approximately five thousand different types of dressings were in use in the five hundred institutions being studied and that as many as fifteen hundred varieties of one type of dressing were used for the same purpose. It was found not only that hospitals located in the same community frequently used entirely different types of dressings for similar work, but that a single hospital, for instance, often carried three or four types of sponges, all for the same purpose but made necessary by special preference of the surgeons or specialists.

Throughout the study it has been constantly kept in mind that surgical dressings are part of the surgeon's armamentarium, and consequently, in compiling a list of standardized dressings, primary consideration has been given to determining sizes and types that will best meet the needs of sound surgical and obstetrical practice. The second purpose or objective of the survey and study has been to design such dressings with a view to reducing costs. The work, therefore, has been based on efficiency and economy in the making up and use of surgical dressings.

Materials used in making dressings vary considerably. Three are recommended. Gauze is the most widely used material but, for the sake of economy and without defeating desired results, cotton may be employed as a dressing if placed between a few layers of gauze. Cellulose wadding

is recommended as an inexpensive substitute for cotton in articles—particularly drainage pads—requiring great absorptive power and less tensile strength.

At the outset of the study a definite classification of surgical dressings and nomenclature was adopted. All surgical dressings used may now be included under one of the seven classifications.

I Sponges—sterile dressings for sponging or wiping

II Abdominal packs—sterile dressings for walling off

III Sterile gauze dressings—sterile gauze dressings to cover incision after operation

IV Pads—sterile dressings to absorb drainage after operation

V Gauze drains or tampons—sterile dressings to serve as wicks to draw blood, pus, or other fluids out of wounds to the surface

VI Bandages—to hold dressings in place or to provide slight pressure or support

VII Binders—to provide pressure or support and hold dressings in place

Standards are submitted for the first four classes: sponges, abdominal packs, sterile gauze dressings, and pads. It is planned to include in a later report recommendations for the three other classes: gauze drains or tampons, bandages, and binders, as well as special dressings. The proposed standardized dressings are as follows:

### *Class I—Sponges*

1 Large sponge (8x4 in.)—20x12 gauze cut 24x18 in., folded to approximately 8x4½ in., 12 ply

2 Medium sponge (3x3 in.)—20x12 gauze cut 12x12 in., folded to approximately 3½x3½ in., 12 ply

3 Small sponge (2x2 in.)—20x12 gauze cut 6x6 in., folded to approximately 1¾x1¾ in., 12 ply

4 Pointed sponge (6x3 in.)—20x12 gauze cut 18x12 in., folded to five corner shape, approximately 6½x4¾ in. The ply varies in different parts of the sponge

5 Tonsil sponge—20x12 gauze cut 6x6 in., folded pouch style to approximately 2x1 in.

### *Class II—Abdominal packs*

6 Large oblong pack—20x16 gauze, dimensions 36x8 in., 8 ply with tape

- 7 Medium oblong pack—20x16 gauze dimensions 18x4 in 8 ply with tape
- 8 Small oblong pack—20x16 gauze dimensions 12x2 in, 8 ply with tape
- 9 Large square pack—20x16 gauze dimensions 12x12 in 8 ply with tape
- 10 Medium square pack—20x16 gauze dimensions 8x8 in 8 ply with tape
- 11 Small square pack—20x16 gauze dimensions 4x4 in 8 ply with tape
- 12 Large roll pack—20x16 gauze folded to approx imately 4 in x 3 yards 8 ply
- 13 Medium roll pack—20x16 gauze folded to approx imately 2 in x 2 yards 8 ply
- 14 Small roll pack—20x16 gauze folded to approx imately 1 in x 1½ yards 8 ply

#### Class III—Sterile gauze dressings

- 15 Large fluff—20x12 gauze cut 18x18 in fluffed
- 16 Small fluff—20x12 gauze cut 12x12 in fluffed
- 17 Large flat—20x12 gauze folded to 4½x18 in 8 ply
- 18 Small flat—20x12 gauze cut 36x12 in folded to 4½x12 in 8 ply

#### Class II—Pads

- 19 Large dressing pad—dimensions 12x16 in Cotton or cellucotton filler with covering of 20x12 gauze
- 20 Small dressing pad—dimensions 8x8 in Cotton or cellucotton filler with covering of 20x12 gauze
- 21 Maternity pad—over all dimensions 22x3½ in Cotton or cellucotton filler 9½ in long with covering of 20x12 gauze

The complete report contains full details as to the making up of each of the types mentioned.

The surgeon's time can be saved still further and a more uniform technique may be obtained if specific uses be determined for each of the several dressings specified. It is, therefore, suggested that each hospital put into practical use the dressings recommended and that the staff appoint a surgical technique committee to make a careful study to determine the particular type of dressing best suited for a given operation. This further determination would enable the surgeon to select in an instant the particular dressing required.

The survey and study included the practices in vogue in regard to sponge count, sterilization methods, storage and distribution and manufacture and reclamation of dressings. The details of these various phases may be found in the complete report as published in the June, 1930 *Bulletin* of the American College of Surgeons. It is believed, however, that all surgeons will be particularly interested in the last two phases, namely, manufacture and reclamation of dressings.

The survey revealed not only the practice in some institutions of reclaiming surgical dressings, but as well the need for a uniform, safe, and reliable method of doing this work. No recommendations have as yet been made as to the advisability of reclaiming surgical dressings, but when

this practice is followed, the following recommendations are suggested:

- 1 Discard all materials contaminated with virulent organisms such as tetanus or gas bacillus and all material stained with iodine, scarlet, or other stains and dyes.
- 2 Handle separately all dressings to be reclaimed—(a) segregate in special containers the dressings to be reclaimed, (b) keep the dressings separate from other laundry material by placing them in cord or mesh bags which should be only partially filled and loosely packed, (c) cleanse these bags of dressings apart from other laundry material.
- 3 Remove gross debris by preliminary soaking.
- 4 Rinse to secure gross cleanliness.
- 5 Boil and bleach at 140 to 150 degrees Fahrenheit.
- 6 Recondition by stretching while moist, dry, and make into packages.
- 7 Sterilize at least twice on successive days.
- 8 Put in proper place ready for use.

After reclamation the material in the dressings should approach its original state with threads intact and mesh preserved. Loose or broken fibers render the gauze unfit for use except as a filler or for special purposes. The reclaimed dressings must be free from stains, odors, and extraneous material, and must be as sterile as new dressings. Proper sterilization calls for cultural tests and where this is not possible the reclaimed gauze should be used only in the secondary line of defense for instance, as a superimposed dressing over new gauze or as an absorptive filler. Before final recommendations for adoption or rejection of the practice are offered, it is desirable that surgeons and hospital executives report their findings as to the value of reclaiming dressings.

Another fact brought out in the study was the growing tendency in hospitals toward the use of ready-made dressings. In view of the large number of dressings used annually, it is evident that considerable manual labor is expended in the hospital in the preparation of dressings. In the past much of this work has been done by nurses in training. More recently, however, it has seemed best that for the better care of the patient and for the better education of the nurse the nurse should be relieved of such menial and unprofessional duties as could be performed by unskilled help or by machines and the preparation of dressings comes in this category. Such work does not contribute to the nurse's efficiency in caring for the patient and, too, if she is relieved of this task, time is thus saved that she could use to better advantage. In a number of hospitals paid employees make dressings, but here, too, there are objections, principally because of the great amount of time and material wasted, for dressings thus prepared are frequently so lacking in uniformity as to be unfit for use. The utilization of convalescent patients or inmates of charitable organizations for the preparation of

dressings is likewise not desirable because such sources of supply are irregular and result in waste of materials. While ready made dressings will be uniform in size and quality and will effect a saving of hospital employees' time, they are an advantage only if their cost is not too high. A comparison of the costs of ready made and hand made dressings however, should include a consideration of the true cost of hand made dressings, for example, the cost of materials, the salary of the nurse, the cost of maintenance and training of the student nurse, and especially the improvement to be obtained in the nursing service by freeing the nursing staff from the duty of making dressings. Detailed time-labor studies of this problem undertaken by hospitals will aid in drawing future conclusions as to the advisability of ready made dressings.

The standardization and simplification of some of the thousands of dressings now in use have been undertaken in the belief that several distinct advantages would accrue to surgeons and hospitals. In the first place standardization will make for uniformity of practice among hospitals of a given community. This is particularly desirable since many surgeons operate in more than one hospital and do work in a number of institutions in the course of a year, and under present conditions the surgeon is very probably given a different set of dressings in each hospital. This necessitates constant readjustment on the part of both surgeon and nurse, which is neither pleasing to the individual nor does it make for efficiency. Maximum efficiency can be secured only if the same technique can be carried out time after time without change—a strong argument in favor of the standardization of dressings.

Standardization will eliminate much of the present waste which results from a hospital making up and carrying several different sizes and shapes of the same type of dressing to meet the preference

of each individual surgeon on the staff. This practice is not only wasteful but it appears that proportionate benefits are not obtained by the surgeon nor is better care secured for the patient. It is believed that the dressings proposed will suffice for most of the requirements of any surgeon and will eliminate the necessity for carrying different types of the same dressing.

The proposed standardized dressings should prove decidedly economical as each has been designed to give the required size and bulk with the minimum amount of material. Each will do the task intended, yet none is larger than necessary for good results. The sizes are such that they can be cut without waste from standard sized packages of gauze, cotton, and cellulose.

One great advantage of standardization is that it will permit the manufacturer to produce ready made surgical dressings much more cheaply. With the present diversity of sizes, the manufacturer sells so few of each dressing that they cannot be produced at low cost. Standardization will encourage quantity production with its consequent economies.

While the proposed dressings are submitted not with the idea of establishing final standards at the outset, it is hoped that they will be put to practical use. As the simplification of dressings concerns both the surgeons and the hospital management, it is essential that the standards be accepted by both in order to secure the best results. It is therefore urged that both the surgical staff and administrative heads of each institution work together in testing out the recommendations made. The ultimate results of proper standardization of surgical dressings, if put into practice by these two bodies, will mean greater convenience to all, a more uniform surgical technique, better utilization of the nurse's time, a saving in time and materials, and a reduction in the cost of dressings.



# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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## PRELIMINARY PROGRAM FOR THE 1930 CLINICAL CONGRESS

THE Committee on Arrangements for the twentieth annual Clinical Congress of the American College of Surgeons, to be held in Philadelphia, October 11-17, has prepared a preliminary program or outline of the clinics and demonstrations to be given in the hospitals and medical schools of that city as published in the following pages. The program is to be further revised and amplified during the weeks preceding the Congress in order to present a more complete outline of the clinical work that will be demonstrated. The surgeons of Philadelphia are keenly interested to provide for the visiting surgeons a complete showing of the clinical surgical activities of that great medical center, to include all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, and surgery of the eye, ear, nose, and throat. It will be noted that clinics are scheduled for Monday afternoon beginning at 2 o'clock and for the mornings and afternoons of the following four days.

The real program of the Congress will be issued daily in the form of bulletins that will give a complete, accurate, detailed schedule of the clinics to be given at each of the hospitals. These bulletins, to be posted at headquarters each afternoon, will present the clinical schedules for the following day. Printed bulletins containing the same schedules will be distributed each morning.

Since the last Clinical Congress in Philadelphia, in 1925, a number of new hospitals have been built and some of the older institutions remodeled and enlarged so that in keeping with the growth

of the city its clinical facilities have been largely increased.

A special feature of the clinical program will be a series of fracture clinics demonstrating modern methods in the treatment of fractures. Plans are being made by the committee for a comprehensive showing at several of the larger hospitals of methods employed and results obtained in the treatment of fractures, which forms so large a part of surgical work in industrial centers and large cities.

Clinical demonstrations in ophthalmology and otolaryngology will be held at headquarters each morning except Monday, in view of the fact that the clinical work in these specialties will be presented at the hospitals in the afternoons. An attractive program which will include demonstrations by a number of outstanding American surgeons recognized as leaders in these specialties, is being arranged by a sub-committee headed by Dr. William T. Shoemaker, chairman, and will be published in an early issue of this journal.

Exhibitions of surgical films will be conducted at headquarters twice daily, except on Monday. At these exhibitions the motion pictures that have been produced under the supervision of or approved by the Board on Medical Motion Pictures will be exhibited. A number of films will be given their premier showing in Philadelphia. The program will include other outstanding contributions not comprised in the College library of films.

Under the auspices of the Committee on the Treatment of Malignant Diseases a round table conference on the subject of cancer clinics, cancer

hospitals and cancer institutes will be held on Thursday morning at which plans for the organization and administration of such institutions will be discussed. Following the annual meeting on Thursday afternoon there will be presented a symposium on cancer dealing with the scientific aspects of this important problem.

A conference on traumatic surgery is being arranged for Friday, with sessions both morning and afternoon, at which leaders in industry, education and labor, together with representatives of indemnity companies, surgeons and hospital administrators will discuss various phases of this important activity of the College. Dr. Frederic A. Besley, Chairman of the Committee on Traumatic Surgery, will report on the work of the committee in recent years, outlining its present and future activities. The program will include an open forum for the discussion of the many problems involved and the presentation of formal papers by outstanding men.

The annual meeting of the College will be held on Thursday afternoon beginning at 2 o'clock at which time formal reports on the activities of the College by the officers and several standing committees will be presented. Immediately following the annual meeting there will be presented a symposium on cancer.

The Executive Committee has under consideration certain plans for the entertainment of visiting ladies which will include visits to some of the important historic points in and around Philadelphia.

General headquarters for the Clinical Congress will be established at the Bellevue-Stratford Hotel located at the corner of Broad and Walnut Streets. All of the rooms on the second floor, including the grand ballroom which will be used for the evening scientific meetings, hospital conference on Monday, the annual meeting and other large gatherings, together with additional rooms on the roof, have been reserved for the use of the Congress and will be utilized for scientific meetings, conferences, film exhibitions, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc.

#### EVENING MEETINGS

Programs for a series of five evening meetings are being prepared by the Executive Committee of the Congress. At the Presidential Meeting on Monday evening, following the introduction of distinguished guests from abroad and the inaugural address of the president elect, Dr. C. Jeff Miller of New Orleans, the Murphy oration in surgery will be delivered by Professor George Grey Turner, Newcastle-on-Tyne, England, pro-

fessor of surgery, University of Durham, and Hunterian professor and member of council, Royal College of Surgeons of England. Other distinguished visitors from abroad who will present scientific papers at the evening meetings include William Ernest Miles, F.R.C.S., surgeon to the Gordon Hospital for Rectal Diseases and the Cancer Hospital of London, who will present a paper on "Cancer of the Rectum", Professor Otfried Foerster, of the University at Breslau, Germany, who will discuss the surgical treatment of neurogenic contractures, Professor Emile de Grosz, of Budapest, Hungary, who will present a paper on ophthalmological surgery.

Three major subjects for consideration at the evening meetings will be plastic surgery, including the treatment of burns, injuries, contractures and congenital deformities, surgery of the kidneys, bladder and ureter, and thoracic surgery. Eminent surgeons of the United States and Canada have been invited to present papers dealing with various phases of these subjects.

The annual Convocation of the College, at which the 1930 class of candidates for Fellowship in the College will be received, will be held on Friday evening.

#### HOSPITAL STANDARDIZATION CONFERENCE

An interesting program of papers, round table conferences and practical demonstrations that deal with problems related to the hospital standardization program of the College and to hospital efficiency in general is being prepared for the thirteenth annual conference, which opens at 9:30 o'clock on Monday morning in the grand ballroom of the Bellevue-Stratford Hotel. A preliminary program follows:

*Monday, 9:30-12:00*

- Opening Address: Major General MERRITT W. IRELAND, Washington, President, American College of Surgeons
- Presentation of the Thirteenth Annual Report of Hospital Standardization: FRANKLIN H. MARTIN, M.D., Chicago, Director General, American College of Surgeons
- Our Responsibility as Fellows of the College in Furthering the Hospital Standardization Movement: C. JEFF MILLER, M.D., New Orleans, President Elect, American College of Surgeons
- What the Hospital Standardization Movement Means to the Present Day Practice of Medicine: GEORGE W. CRILE, M.D., Cleveland, Director, Cleveland Clinic
- My Conception of an Ideal Hospital: Rev. ALPHONSE M. SCHWITALA, St. Louis Dean, St. Louis University School of Medicine, President, Catholic Hospital Association
- Is Standardization of Hospital Surgical Procedures Possible? JOSEPH C. DOANE, M.D., Philadelphia, Director, Jewish Hospital

Monday 2 00-5 00

FRANK D. JENNINGS M.D. Brooklyn Clinical Professor of Surgery Long Island College Hospital, Surgeon St. Catherine's Hospital presiding

A Study of Acute Appendicitis at St. Catherine's and Greenpoint Hospitals Brooklyn from 1919 to 1929 inclusive for the Purpose of Evaluating the Benefit of Staff Conferences. JOSEPH S. BALDWIN M.D. Attending Surgeon Greenpoint and Holy Family Hospitals, HARRY FELDMAN M.D. Associate Surgeon Greenpoint Hospital, JOHN A. MCCABE M.D. Assistant Surgeon, Greenpoint and St. Catherine's Hospitals, JOSEPH L. FREYER M.D. Assistant Surgeon St. Catherine's Hospital, WALTER J. O'CONNELL M.D. Assistant Surgeon St. Catherine's Hospital

Co-ordination and Integration of the Gynecological Obstetrical Service in a General Hospital. CHARLES A. GORDON M.D. Brooklyn Clinical Professor of Obstetrics and Gynecology Long Island College Hospital, Attending Obstetrician and Gynecologist Greenpoint and St. Catherine's Hospitals

A Plan for the Organization and Control of the Courtesy Staff in a General Hospital. JOHN M. DEANVILLE M.D. Jamaica N.Y. Attending Surgeon St. Catherine's Hospital Brooklyn, Attending Surgeon Mary Immaculate Hospital Jamaica

The Liaison Committee—a Means of Promoting Co-operation between the Medical Staff and the Hospital Management. J. GARLAND SHERRILL M.D. Louisville Visiting Surgeon Louisville Public Jewish and St. Mary and St. Elizabeth Hospitals

Is the Private Patient Getting a Square Deal? JOHN E. JENNINGS M.D. Surgeon in Chief Cumberland Hospital Surgeon Brooklyn and St. Peter's Hospitals

Tuesday 9 30-12 30

Important Basic Considerations in Maintaining an Adequate X-Ray Service in Various Sized Hospitals. EDWARD S. BLAIR M.D. Chicago Radiologist Wesley Memorial Hospital

Autopsies Their Value and Certain Factors that Will Influence Their Increase. B. HENRY MASON M.D. Waterbury Conn., Superintendent, Waterbury Hospital

Absorption of Special Charges in Hospitals (Illustrated). LAWRENCE C. ALSTIN Milwaukee Superintendent Mount Sinai Hospital

The Hospital's Teaching Responsibility. JOHN E. RAYSON Baltimore Assistant Director Johns Hopkins Hospital

Tuesday, 2 00-5 00

Round Table Conference—Functions, Relationships and Responsibilities of the Board of Trustees, Medical Staff and Superintendent. Conducted by C. H. MÜNGER M.D. Valhalla N.Y. Director Westchester County Department of Hospitals

Wednesday 9 30-12 30

Organization of the Record Department (Illustrated). PAUL H. FELLER Minneapolis, Superintendent, University Hospitals

Centralization of Medical Statistics in the Record Department. MARY M. NEWTON R.N. Pittsburgh Medical Statistician Pittsburgh Homeopathic Hospital

Role of the Student Nurse in the Clinical Record. MARY MERRILL Williamsport Student Nurse School of Nursing Williamsport Hospital

Case Records and Clinical Conferences. IRVIN D. MEYER M.D. Pittsburgh President, Pennsylvania State Board of Medical Education and Licensure

Wednesday 2 00-5 00

Round Table Conference—Medical and Hospital Economics Conducted by ROBERT JOLLY Houston Texas Superintendent Baptist Hospital Educating the Public, Costs versus Value of Medical and Hospital Services Medical and Hospital Economics in relation to planning and construction management scientific departments clinical laboratory X-ray and physical therapy, Standardization of Equipment and Supplies Group Nursing Role of the Social Worker Role of the Dietitian

Round table conferences dealing with subjects of interest to hospital trustees, superintendents, nurses and all hospital executives are being planned for Thursday and Friday mornings. The afternoons of those two days will be devoted to visits to hospitals with demonstrations on hospital planning and construction, equipment, management, etc.

An invitation to attend the conference is extended to all persons interested in the hospital field.

#### REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Philadelphia session of the Clinical Congress so that the total fare for the round trip will be one and one half the ordinary first class one way fare. To take advantage of the reduced rates it is necessary to pay the full one way fare to Philadelphia, procuring from the ticket agent when purchasing ticket, a "convention certificate" which certificate is to be deposited at head quarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of a visé certificate to the ticket agent in Philadelphia not later than October 21st a ticket for the return journey by the same route as traveled to Philadelphia may be purchased at one half the one way fare.

In the eastern, central and southern states and eastern provinces of Canada tickets may be purchased between October 9th and 15th, in other sections of the United States and Canada at somewhat earlier dates. The return journey from Philadelphia must be begun not later than October 21st.

The reduction in fares does not apply to Pullman fares, nor to extra fares charged for passage on certain trains. Local railroad ticket agents

will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to Philadelphia, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and vised by a special railroad agent in Philadelphia during the meeting. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used to Philadelphia and that the certificate must be deposited at headquarters during the meeting and return ticket purchased and used not later than October 21st.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including September 30th with a final return limit of October 31st. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to Philadelphia via a direct route and returning via another direct route with liberal stop over privileges.

#### LIMITED ATTENDANCE—ADVANCE REGISTRATION

Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets. This plan provides an efficient means for the distribution of the visiting surgeons among the several clinics, and insures against overcrowding,

as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

#### REGISTRATION FEE

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

#### PHILADELPHIA HOTELS AND THEIR RATES

There are ample first-class hotel facilities available in Philadelphia for all who will attend, as in recent years a number of fine hotels have been built. Many of the hotels are located within walking distance of the headquarters hotel. The following hotels are recommended by the Committee on Arrangements.

	Minimum Rates with Bath	
	Single Room	Double Room
Adelphia, 13th and Chestnut Sts	\$ 4.00	\$ 7.00
Barclay, Rittenhouse Square East	6.00	8.00
Bartram, 33rd and Chestnut Sts		8.00
Belgravia, 1811 Chestnut St	4.00	7.00
Bellevue Stratford, Broad and Walnut	5.00	7.00
Benjamin Franklin, 9th and Chestnut	4.00	7.00
Colonial, 11th and Spruce Sts	4.00	7.00
Drake, 1512 Spruce St	5.00	8.00
Elks, Broad and Vine Sts	2.50	5.00
Gladstone, 11th and Pine Sts	4.00	7.00
Green, 8th and Chestnut Sts	3.00	4.50
Lorraine, Broad and Fairmount Ave	5.00	9.00
Madstone, 1327 Spruce St	3.00	5.00
Majestic, Broad and Girard Ave	4.00	6.00
Mayfair, Lincoln Drive and Johnson St	5.00	8.00
Pennsylvania, 39th and Chestnut Sts	3.00	5.00
Ruttenhouse, 22nd and Chestnut Sts	3.00	5.00
Ritz Carlton, Broad and Walnut Sts	6.00	10.00
Robert Morris, 17th and Arch Sts	3.50	5.00
St James, 13th and Walnut Sts	3.50	5.00
Stephen Girard, 2027 Chestnut St	3.00	5.00
Sylvania, Juniper and Locust Sts	4.00	8.00
Tracy, 36th above Chestnut St	3.00	5.00
Waltton, Broad and Locust Sts	3.50	5.00
Warwick, 17th and Locust Sts	5.00	8.00
Wellington, 19th and Walnut Sts	5.00	6.00
Westbury, 15th and Spruce Sts	5.00	10.00

## PRELIMINARY CLINICAL PROGRAM

## GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

## LANEKENAU HOSPITAL

## Monday

JOHN B. DEEVER—12 General surgical clinic  
WILLIAM MACINNEN—3 Cystoscopy

## Tuesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration

## Wednesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
COLBY ENGEL—9 Injection treatment of varicose veins  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Thursday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration  
JOHN B. DEEVER—12 General surgical clinic

## Friday

COLBY ENGEL—9 Injection treatment of varicose veins  
STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
MRS MCNETT—9 Exhibition of drawings of pathological specimens  
MISS JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration  
WILLIAM MACINNEN—3 Cystoscopy

## METHODIST EPISCOPAL HOSPITAL

## Tuesday

DAMON B. PFEIFFER and CALVIN M. SMITH, JR.—9 General surgical operations

## Wednesday

JOHN C. HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
JAMES H. BALDWIN—9 General surgical operations

## Thursday

GEORGE SCHWARTZ—9 General surgical operations

## Friday

DAMON B. PFEIFFER and CALVIN M. SMITH, JR.—9 General surgical operations

## UNIVERSITY HOSPITAL

## Tuesday

CHARLES C. MORRIS, C. A. BEINFELD and D. P. MURPHY—9 Gynecological operations and demonstration of cases  
DRS. MILLER OVERHOLT and RADFEMAKER—9 Surgical clinic abdominal cases  
EDMUND B. PIPER and staff—9 Obstetrical operations  
C. H. FRAZER and F. C. GRANT—9 Neurosurgical clinic  
DRS. MILLER OVERHOLT and RADFEMAKER—1 Dry clinic Special tests used in the study of vascular disturbances, opaque solutions available in the recent genological study of surgical patients factors in the production of chills following intravenous infusions, intraperitoneal and intrapleural pressure relation ships the course of events in acute appendicitis  
I. S. RAVIN—2 Gall bladder surgery, operations and demonstration of cases  
C. H. FRAZER and F. C. GRANT—2 30 Neurosurgical clinic, demonstration of interesting cases

## Wednesday

I. LOYD E. KEENE and staff—9 Gynecological operations  
E. L. ELIASON and staff—9 General surgical clinic  
F. C. GRANT—9 Neurosurgical clinic  
A. BRUCE GILL and staff—2 Orthopedic surgery, dry clinic with demonstration of end results

## Thursday

C. H. FRAZER and F. C. GRANT—9 Neurosurgical operations  
DRS. MILLER OVERHOLT and RADFEMAKER—9 Surgical clinic thoracic cases, operations and demonstration of cases  
EDMUND B. PIPER and staff—9 Obstetrical operations  
DRS. MILLER OVERHOLT and RADFEMAKER—2 Dry clinic Results in the surgical treatment of lung abscess, methods of treating empyema presentation of follow up chest cases of lung abscess bronchitic toxic chills empyema and pulmonary tuberculosis  
A. BRUCE GILL and staff—2 Orthopedic operations  
B. J. ALPERT—2 30 Neuropathological conference

## Friday

C. H. FRAZER—9 Neurosurgical clinic  
I. LOYD E. KEENE and staff—9 Gynecological operations  
EDMUND B. PIPER—9 Obstetrical operations  
E. L. ELIASON and staff—9 Fracture clinic

## FRANKFORD HOSPITAL

## Tuesday

C. F. NABAU, L. D. ENGLERTH and B. CHANDLER—9 General surgery

## Wednesday

EDWARD SCHUMANN and FREDERICK KELLER—9 Gynecological clinic

## Thursday

W. E. PARKER—9 Gynecological clinic  
GEORGE HANNA—9 Obstetrical clinic  
L. D. ENGLERTH and B. CHANDLER—2 Fracture clinic

## JEFFERSON HOSPITAL

*Tuesday*

- P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 J TORRANCE RUGH and staff—10 Orthopedics  
 J CHALMERS DA COSTA and staff—11 General surgery  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 JOHN H GIBBON and staff—2 General surgery

*Wednesday*

- BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 J CHALMERS DA COSTA and staff—2 General surgery

*Thursday*

- P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—10 Genito urinary surgery  
 J CHALMERS DA COSTA and staff—11 General surgery  
 J TORRANCE RUGH and staff—11 Orthopedic surgery  
 P BROOKE BLAND and staff—4 Obstetrics

*Friday*

- BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 JOHN H GIBBON—11 General surgery

## MT SINAI HOSPITAL

*Monday*

- MOSES BEHREND—1 15 General surgical operations

*Tuesday*

- BENJAMIN LIPSHUTZ—9 General surgical operations  
 ALEXANDER RANDALL—1 30 Urological clinic, operations and demonstration of cases

*Wednesday*

- CHARLES MAZER—9 Operative gynecology  
 MORRIS COOPERMAN—2 Orthopedic clinic, operations and demonstration of cases

*Thursday*

- BERNARD MANN—9 Operative gynecology  
 ALEXANDER RANDALL—1 30 Urological clinic, operations and demonstration of cases

*Friday*

- BENJAMIN LIPSHUTZ—9 General surgical operations and demonstration of cases  
 MOSES BEHREND—1 General surgical operations and demonstration of cases

## WOMAN'S HOMEOPATHIC HOSPITAL

*Tuesday*

- FRANÇOIS L HUGHES—9 Gynecological clinic

*Wednesday*

- ARTHUR HARTLEY—9 General surgical clinic

## GRADUATE HOSPITAL

*Monday*

- GEORGE E PFAHLER—2 Radiation in diagnosis of malignant diseases  
 GEORGE PIERSON—2 Dry clinic Cardioresenal cases  
 ORLANDO PETTY—4 Demonstration of diabetes cases

*Tuesday*

- H L BOCKUS—9 Gastro intestinal diagnosis  
 WALTER L LEE—9 General surgical clinic  
 R A THOMAS—2 Genito urinary operations

*Wednesday*

- JOHN P JOYSON—9 General surgery  
 H L BOCKUS—2 Gastro intestinal diagnosis  
 EUGENE A CASE—2 Surgical pathology  
 GEORGE PIERSON—2 Dry clinic Cardioresenal cases

*Thursday*

- EUGENE A CASE—2 Surgical pathology  
 C F MARTIN and W O HERMANCE—9 Rectal infections

*Friday*

- J B CARNETT—9 General surgical clinic  
 R A THOMAS—2 Genito urinary operations  
 GEORGE PIERSON—2 Dry clinic Cardioresenal cases  
 GEORGE E PFAHLER—2 Radiation in diagnosis and treatment of malignant diseases

## CHESNUT HILL HOSPITAL

*Tuesday*

- JOHN MCCLOSLEY—10 30 General surgical clinic  
 DRs SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

*Thursday*

- CHARLES BEHNEY—9 Operative gynecology  
 ALEXANDER RANDALL—9 Urological clinic

*Friday*

- W C SHEEHAN and L HERGESHEIMER—9 General surgery  
 DRs SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## JEANES HOSPITAL

*Wednesday*

- R W TEAHAN—2 Carcinoma of breast  
 C A WHITCOMB—2 Lung tumors  
 E E DOWNS—2 The saturation method of X ray treatment  
 W S HASTINGS—2 Exhibition of interesting pathological specimens

*Thursday*

- R W TEAHAN—2 Carcinoma of skin  
 C A WHITCOMB—2 Mediastinal masses  
 E E DOWNS—2 Exhibition of interesting X ray films  
 W S HASTINGS—2 Exhibition of interesting pathological specimens

## ST CHRISTOPHER'S HOSPITAL

*Tuesday*

- Staff—10 General surgery

*Friday*

- R L JOHN—10 Orthopedics

## TEMPLE UNIVERSITY HOSPITAL

## Monday

- WILLIAM A STEEL—1 Surgical operations  
 W HERSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Surgical treatment of epilepsy  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference roentgenologic diagnosis of hypertrophied gastric mucosa and pedunculated tumors of the stomach prolapsing into the duodenum  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Tuesday

- TEMPLE FAY—9 Neurosurgical clinic encephalography  
 W WAYNE BARCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 HARRY HUDSON—1 Orthopedic surgery  
 TEMPLE FAY—3 Management of traumatic injuries to the brain  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference roentgenologic diagnosis of liver abscess and subdiaphragmatic collections  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Wednesday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic, spinal cord tumor cases  
 W WAYNE BARCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12 Operative gynecology  
 WILLIAM A STEEL—1 General surgical operations  
 H Z HISSMAN—3 Atypical neuralgia and trigeminal neuralgia  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference roentgenologic study of the neck and upper respiratory tract  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Thursday

- TEMPLE FAY—9 Neurosurgical clinic cerebellar tumor cases  
 W WAYNE BARCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12 Operative gynecology  
 WILLIAM A STEEL—12 Buerger's clinic operative and ambulant cases  
 JESSE ARNOLD—1 Obstetrics  
 TEMPLE FAY—3 Neurological clinic hydration rates, normal in eclampsia and uremia, and acute toxic states  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Friday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic gangliectomy or sympathectomy  
 W WAYNE BARCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12 Operative gynecology  
 WILLIAM A STEEL—1 Operative surgery

- W HERSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Neurosurgical clinic  
 EUGENE P PENDERGRASS—3 Surgical radiologic conference encephalography  
 FRANK W KONZELMAN—4 Surgical pathological conference

## EPISCOPAL HOSPITAL

## Monday

- H C DEANER—1 30 General surgical clinic

## Tuesday

- LOUIS H MUTSCHLER—11 30 General surgical clinic  
 JOHN B HAINES—2 Urological clinic  
 TEMPLE FAY—3 Neurosurgical clinic

## Wednesday

- A P C ASHBURST—9 General surgical clinic  
 R L JOHNS—1 30 Orthopedic clinic  
 R S BROMER—2 X ray demonstration

## Thursday

- ROBERT H IVEY—9 Oral surgery  
 F G ALEXANDER—9 General surgical clinic  
 H C DEANER—1 30 General surgical clinic

## Friday

- LOUIS H MUTSCHLER—11 30 General surgical clinic  
 JOHN B HAINES—2 Urological clinic

## ST AGNES HOSPITAL

## Monday

- WILBUR HAINES and F MICELI—2 Urological clinic

## Tuesday

- E C MURPHY—9 General surgical clinic  
 LEONARD AVERETT—10 Gynecological clinic

## Wednesday

- J W BRANSFIELD—9 General surgical clinic  
 G M DORRANCE—2 General surgery and cleft palate clinic  
 WILBUR HAINES—2 Urological surgery

## Thursday

- J F A JONES—9 General surgical clinic  
 JOHN A. McGUIRE—10 Gynecological clinic  
 W W VAN DOLSE—11 Obstetrical clinic

## Friday

- G M DORRANCE—9 General surgical clinic  
 WILBUR HAINES and F MICELI—2 Urological clinic

## PENNSYLVANIA HOSPITAL

## Tuesday

- CHARLES F MITCHELL and associates—9 Surgical clinic

## Wednesday

- JOHN H GIBBO and associates—9 Surgical clinic

## Thursday

- CHARLES F MITCHELL and associates—9 Surgical clinic

## Friday

- JOHN H GIBBO and associates—9 Surgical clinic

## HAHNEMANN HOSPITAL

*Monday*

- H P LFOFOLD—2 Hernia clinic  
D B JAMES and staff—2 Operative gynecology

*Tuesday*

- A B WEBSTER—9 Fracture clinic  
JOHN E. JAMES and staff—2 Obstetrics  
L T ASHCRAFT and staff—2 Genito urinary surgery

*Wednesday*

- L T ASHCRAFT and FRANK BENSON—9 Neoplasms of the genito urinary tract  
H L NORTHROP—2 General surgical clinic

*Thursday*

- J DEAN ELLIOTT—9 General surgical clinic  
D B JAMES and staff—9 Operative gynecology  
JOHN A BROOKE and staff—2 Dry clinic, orthopedic surgery

*Friday*

- H L NORTHROP and staff—9 General surgical clinic  
FRANK BENSON—9 Indications for radium treatment

## CHILDREN'S HOSPITAL

- WALTER ESTELL LEE Surgical clinic  
WILLIAM A JAQUETTE Dental clinic  
HOWARD CHILDS CARPENTER Preventive medicine in reference to surgical diseases in children  
SUSAN C FRANCIS, R N Hospital management from surgical viewpoint  
J C GITTINGS Medical aspect of surgical cases in children  
RALPH S BROMER Roentgenological aspect of children's diseases  
EDWARD F CORSON Bone syphilis and other allied surgical conditions  
C C NORRIS Vaginitis clinic

## ORTHOPEDIC HOSPITAL

*Tuesday*

- A P C ASHHURST, R L JOHN and E T CROSSAN—1 Out patient clinic  
A B GILL—9 Orthopedic operations

*Thursday*

- A P C ASHHURST—9 Orthopedic operations  
WILLIAM J TAYLOR—1 Out patient clinic

*Friday*

- WILLIAM J TAYLOR—1 Orthopedic operations

## WOMAN'S MEDICAL COLLEGE HOSPITAL

*Tuesday*

- HUBLEY R OWEN—9 General surgery

*Wednesday*

- MARGARET C STURGIS—9 Demonstration of the use of carbon dioxide tubal insufflation and uterosal pingograms in the diagnosis of sterility

*Thursday*

- CATHARINE MACFARLANE—9 Gynecological clinic

*Friday*

- JOHN S RODMAN—9 General surgery

## PRESBYTERIAN HOSPITAL

*Tuesday*

- E B HODGE and H P BROWN—9 General surgery  
A B GILL and T ORR—2 Orthopedics

*Wednesday*

- D B PFEIFFER and J S RODMAN—9 General surgery  
B A THOMAS, J C BIRDSALL and F G HARRISON—2 Genito urinary surgery

*Thursday*

- J H JOHNSON and W E CHRISTIE—9 General surgical operations  
J H GIVIN, G M LAWS and J P LEWIS—2 Gynecological operations

*Friday*

- J SPEESE and F A BOTHE—9 General surgery

## NORTHWESTERN GENERAL HOSPITAL

*Monday*

- J S RAUDENBUSH—2 Gynecology

*Tuesday*

- J B MENCAL, ROBERT BOYER and E B PARKER—9 General surgical operations  
ARTHUR D KURTZ—2 30 Orthopedic clinic

*Wednesday*

- J B MENCAL, ROBERT BOYER and E B PARKER—9 General surgical operations  
J S RAUDENBUSH—12 Gynecology  
E C DAVIS—3 Rectal clinic

*Thursday*

- J B MENCAL, ROBERT BOYER and E B PARKER—9 General surgical operations  
L F MILLIKEN—2 30 Genito urinary surgery

## NORTHEASTERN HOSPITAL

*Tuesday*

- E C DAVIS—2 Proctology  
T T THOMAS and J C SCOTT—3 Dry clinic, fractures and dislocations

*Wednesday*

- J B LOWNES—4 Genito urinary surgery

*Thursday*

- J S RAUDENBUSH—2 Gynecology and obstetrics  
T T THOMAS—3 General surgery

## U S NAVAL HOSPITAL

*Tuesday*

- Staff—9 Surgical operations

*Wednesday*

- Staff—9 Surgical operations

*Thursday*

- Staff—9 Surgical operations

*Friday*

- Staff—2 Discussion of surgical cases or surgical topics



## PHILADELPHIA GENERAL HOSPITAL

## Tuesday

M P WARMUTH—9 General surgery  
FRANK C HAMMOND—9 Gynecology and obstetrics

## Wednesday

J T RICH—9 Orthopedics  
HUBLEY OWEN—9 General surgery

## Thursday

JOHN O BOWER—9 General surgery  
E A SCHUMANN—9 Gynecology and obstetrics  
WILLIAM H MACKENZIE—2 Genito urinary surgery

## Friday

HARVEY M RIGHTER—9 General surgery  
Staff—2 X ray demonstration

## JEWISH HOSPITAL

## The day

PHILIP WILLIAMS and E SCHULMAN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic

WILLIAM H KELLER— General surgical operations

## Wednesday

FRANK B BLOCK—9 General surgical operations  
MOSES BEHREND—11 General surgical clinic  
THOMAS STELLWAGEN and JOHN B LOWMEYER—2 Urological operations  
LEON BRINKMAN—2 General surgical operations

## Thursday

MOSES BEHREND—9 General surgical clinic, moving pictures gastro enterological cases

## Friday

PHILIP WILLIAMS and E SCHULMAN—9 Operative gynecology  
RALPH GOLDSMITH—10 Fracture clinic

WILLIAM H KELLER—2 General surgical operations

## ST MARY'S HOSPITAL

## Tuesday

JAMES A JILL—9 General surgery  
WILLIAM J RYAN—9 General surgery  
WILLIAM E FARNE—1 Obstetrical clinic

## Wednesday

A P KRECAN—9 General surgery  
WILLIAM MORRISON—9 Gynecology

## Thursday

HENRY K SEPLALS—9 General surgery  
JOSEPH TOLAND—9 Gynecology  
J STUART LAWRENCE—1 Obstetrical clinic

## Friday

P A MCCARTHY—9 General surgery  
LEO WOJCZYNSKI—9 Gynecology

## BABIES HOSPITAL

## Tuesday

JOHN SE CLAIR and WILLIAM BATES—2 30 Presentation of follow up cases of intussusception and congenital hypertrophied stenosis

## Thursday

JOHN SE CLAIR and I BENDER—2 30 Conservative treatment of cervical adenitis

## MISERICORDIA HOSPITAL

## Tuesday

J A KELLY and B R BELTRAN—9 General surgical operations

F MOCVERO—11 Pre and postoperative care

## Wednesday

G P MILLER and T RYAN—9 General surgical operations

DR DOUGHERTY—11 Fractures of the femur

## Thursday

J A KELLY and B R BELTRAN—9 General surgical operations

J A SHARKEY and D C GEIST—11 Blood transfusion, operative results in fractures

## Friday

G P MILLER and T RYAN—9 General surgical operations

J B CARNONE and E J GARVIN—11 General surgical clinic

## STETSON HOSPITAL

## Monday

CARL F KOENIG—1 30 X ray demonstration

## Tuesday

WILLIAM T ELLIS and JOHN A BOGER—12 General surgery

## Wednesday

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 X ray demonstration

## Friday

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 X ray demonstration

## PENNSYLVANIA HOSPITAL

(Maternity Department and Lying In Hospital)

## Tuesday

N W VAUX and staff—9 Obstetrics and gynecology

## Wednesday

E B PIPER and staff—9 Obstetrics and gynecology

## Thursday

N W VAUX and staff—9 Obstetrics and gynecology

## Friday

E B PIPER and staff—9 Obstetrics and gynecology

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## The day

JOHN DEAN ELLIOTT T C GARY and THOMAS DOYLE—9 General surgical clinic

LEON T ASHFORTH—2 Urological surgery

## Wednesday

JOHN A BROOKE—2 Orthopedic surgery

## Thursday

NATHANIEL F LAFFERTY—2 Gynecological clinic  
NEWLEN F PAXSON—2 Lipiodol study of fallopian tubes

## Friday

WARREN C MERCER—2 Postnatal clinic.

## COOPER HOSPITAL

(Camden)

*Tuesday*

- P M MECCRAY, A S ROSS, F W SHAFER, and I E DEIBERT—9 General surgical operations  
T B LEE, A B DAVIS, and G F WEST—9 Operative gynecology and obstetrics  
I E DEIBERT and R S GAMON—10 Fracture clinic

*Wednesday*

- P M MECCRAY, A S ROSS, F W SHAFER, and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
A H LIPPINCOTT and D F BENTLEY—2 Urological operations  
P M MECCRAY, A S ROSS, F W SHAFER, and I E DEIBERT—2 End results in fracture cases  
B F BUZBY—3 Demonstration of orthopedic cast and end results

*Thursday*

- P M MECCRAY, A S ROSS, F W SHAFER, and I E DEIBERT—9 General surgical operations  
T B LEE, A B DAVIS, and G F WEST—9 Operative gynecology and obstetrics  
A S ROSS—1 End results in industrial injuries (New Jersey State Clinic)

*Friday*

- P M MECCRAY, A S ROSS, F W SHAFER, and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
I E DEIBERT and R S GAMON—10 Fracture clinic

## ST JOSEPH'S HOSPITAL

*Monday*

- FRANCIS J McCULLOUGH—3 Obstetrical clinic

*Tuesday*

- MELVIN M FRANKLIN—9 Fractures in children  
F HURST MAIER—10 Gynecological operations

*Wednesday*

- JAMES A KELLY—9 General surgical clinic  
JOHN F A JONES—9 General surgical clinic

*Thursday*

- ALEXANDER E BURKE—8 Gynecological surgery  
F HURST MAIER—10 Gynecological surgery  
CHARLES I NASSAU—10 General surgery

*Friday*

- MELVIN M FRANKLIN—9 Surgery of children  
FRANCIS J McCULLOUGH—3 Obstetrical clinic

## EVANS DENTAL INSTITUTE

*Tuesday*

- ROBERT H IVY—9 Fracture of the jaw

*Wednesday*

- LAWRENCE CURTIS—9 Oral surgical clinic

*Thursday*

- ROBERT H IVY and LAWRENCE CURTIS—9 Oral surgical clinic

## ST LUK'S AND CHILDREN'S HOMOEOPATHIC HOSPITAL

*Tuesday*

- A B WEBSTER—9 Surgical clinic  
WARREN C MERCER and staff—9 Obstetrical clinic

*Wednesday*

- HERBERT P LEOPOLD and staff—9 Surgical clinic  
WILLIAM C HUNSICKER and staff—9 Urological clinic

*Thursday*

- H K ROESSLER—9 Surgical clinic  
RICHARD W LARER, JOHN A BROOKE and staff—9 Orthopedic clinic  
JAMES D SCHOFIELD and staff—9 Clinic on diseases of the rectum  
WESTON D BAXLEY and associates—2 Neurosurgical symposium on injuries of the head  
FRANK C BENSON and staff—2 Dry clinic Indications and contra indications for use of radium in myopathic hæmorrhage  
G MORRIS GOLDEN and group—2 Dry clinic and symposium on pre and postoperative problems of toxic goiter

## WOMAN'S HOSPITAL

*Tuesday*

- EMILY W AUCE—9 General surgery

*Wednesday*

- FAITH S FETTERMAN—9 Cystoscopic demonstration

*Thursday*

- LIDA S COGILL—2 Obstetrical demonstration

*Friday*

- MARIE FORMAD—9 Gynecological clinic

## KENSINGTON HOSPITAL FOR WOMEN

*Tuesday*

- H C DEEVER—12 General surgery

*Wednesday*

- WILLIAM L PARKE—10 General surgery  
JOHN B HAINES—3 30 Cystoscopic clinic

*Friday*

- H C DEEVER—12 General surgery

## GERMANTOWN HOSPITAL

*Wednesday*

- WILLIAM B SWARTLEY—10 General surgery

*Friday*

- WILLIAM B SWARTLEY—10 General surgery

## AMERICAN ONCOLOGIC HOSPITAL

*Tuesday*

- ALBERT E BOTHE, CHARLES E CODMAN, GEORGE M DORRANCE, WILLIAM C HUEPER, BRADY A HUGHES, C B LONGENECKER, SAMUEL MCCLARY III, ELLICE McDONALD, WILLIAM S NEWCOMET, DAMON B PFEIFFER, WILLIAM D ROBINSON, JESSE W SMITH, WILLIAM H SPENCER and S E TRACY—9 Clinical conference with exhibition of patients Fibroid tumors breast cases, congenital mouth cases, hemangiomas, etc

## SURGERY OF THE EYE, EAR, NOSE AND THROAT

## EPISCOPAL HOSPITAL

## Monday

FREDERICK KRAUSS—2 Eye clinic  
W R WATSON—2 Ear, nose and throat clinic

## Tuesday

HAROLD VON GOLDBERG—2 Eye clinic

## Wednesday

W R WATSON—1 30 Ear, nose and throat clinic  
A G FEWELL—3 Eye clinic

## Thursday

C C BILDREY—1 30 Ear, nose and throat clinic  
FREDERICK KRAUSS—1 30 Eye clinic

## Friday

C C BILDREY—1 30 Ear, nose and throat clinic  
HAROLD VON GOLDBERG—1 30 Eye clinic

## TEMPLE UNIVERSITY HOSPITAL

## Monday

MATTHEW TRENKLE—3 Operative otology

## Tuesday

CHEVALIER JACOBSON and associates—8 30 Bronchoscopic clinic  
ROBERT RIDGPATH—2 Laryngological clinic  
LUTHER C FETTER—3 Operative ophthalmology

## Wednesday

CHEVALIER JACOBSON and associates—8 30 Bronchoscopic clinic

## Thursday

CHEVALIER JACOBSON and associates—8 30 Bronchoscopic clinic  
ROBERT RIDGPATH—3 Operative laryngology  
LUTHER C FETTER—4 Ophthalmological surgery

## Friday

CHEVALIER JACOBSON—8 30 Bronchoscopic clinic  
MATTHEW TRENKLE—4 Otological clinic

## ST MARY'S HOSPITAL

## Tuesday

WILLIAM GRADY—3 Otolaryngology

## Wednesday

F A MURPHY—3 Ophthalmology

## Thursday

R. T. M. DONNELLY—3 Ophthalmology  
EDWARD MURPHY—3 Otolaryngology

## JEWISH HOSPITAL

## Wednesday

J C FRIEPE—3 Ophthalmological operations

## Thursday

A S KAUFMAN and P F RIDGPATH—4 Otolaryngological operations

## LANKENAU HOSPITAL

## Monday

W J CREIGHTON and DR SMITH—1 Eye clinic

## Tuesday

W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BARRETT—2 Ear, nose and throat clinic

## Wednesday

W J CREIGHTON and DR SMITH—1 Eye clinic

## Friday

W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BARRETT—2 Ear, nose and throat clinic

## JEFFERSON HOSPITAL

## Tuesday

LOUIS H CLEFF and staff—9 Bronchoscopy  
F O LEWIS and staff—9 Nose and throat operations

## Wednesday

F O LEWIS and staff—10 Carcinoma of larynx  
LOUIS H CLEFF and staff—11 Bronchoscopy

## Thursday

LOUIS H CLEFF and staff—9 Bronchoscopy  
F O LEWIS and staff—9 Nose and throat operations

## Friday

C E G SHANNON and staff—3 Ophthalmology

## PRESBYTERIAN HOSPITAL

## Monday

H M LANGDON and J M THORNTON—2 Ophthalmology

## Friday

V P STAEFFER, W CARIS, and O R KLINE—2 Otolaryngological operations

## WOMAN'S MEDICAL COLLEGE HOSPITAL

## Tuesday

MARGARET F BUTLER—2 Ear, nose and throat clinic

## Friday

MARGARET F BUTLER—2 Ear, nose and throat clinic

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## Thursday

GILBERT J PALEY, CARROLL HAINES, H BAILEY CHALFONT and EVERETT A TYLER—2 Tonsillectomy and adenoidectomy clinic adults and children under gas anesthesia

## WOMAN'S HOMEOPATHIC HOSPITAL

## Thursday

JOSEPH V F CLAY, J R CRISWELL and CHARLES J V FRIES, Jr—2 Nose and throat clinic

## MISERICORDIA HOSPITAL

*Monday*

J E LOFTUS—2 Otolaryngological operations

*Tuesday*

C T MCCARTHY—2 Otolaryngological operations

*Wednesday*

J E LOFTUS—2 Otolaryngological operations

*Thursday*

C T MCCARTHY—2 Otolaryngological operations

*Friday*

J E LOFTUS—2 Otolaryngological operations

## ST CHRISTOPHER'S HOSPITAL

*Monday*

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

*Wednesday*

H J WILLIAMS or E H CAMPBELL—9 Nose and throat clinic

*Thursday*

DR FELDMAN—10 Eye clinic

*Friday*

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

## HAHNEMANN HOSPITAL

*Tuesday*

H S WEAVER and staff—2 Ear, nose and throat clinic

*Thursday*

H S WEAVER and staff—2 Ear, nose and throat clinic

*Friday*

FRANK NAGLE and FRED PETERS—9 Cataract operations

## COOPER HOSPITAL

(Camden)

*Tuesday*

A M ELWELL—2 Otolaryngological operations

*Thursday*

A M ELWELL—2 Otolaryngological operations

## MT SINAI HOSPITAL

*Monday*

C W LEFEVER—3 30 Eye clinic, operations and demonstration of cases

*Tuesday*

LEWIS FISHER—1 Ear, nose and throat clinic, operations and demonstration of cases

*Wednesday*DAVID HUSIA—2 30 Ear, nose and throat clinic  
GABRIEL TUCKER—4 Bronchoscopy*Thursday*

MORRIS WEINSTEIN—2 Ear, nose and throat clinic, operations and demonstration of cases

*Friday*

MATTHEW ERSNER—1 Ear, nose and throat clinic, operations and demonstration of cases

## ST JOSEPH'S HOSPITAL

*Tuesday*

GEORGE MORLEY MARSHALL—9 The Marshall operation for nasal deformity with end results

A J KEENAN—3 Otolaryngological operations

*Wednesday*

ARTHUR WRIGLEY—9 Otolaryngological operations

*Thursday*

GEORGE MORLEY MARSHALL—9 The radical mastoid with end results

C T MCCARTHY—2 Otolaryngological operations

*Friday*

FRANCIS V GOWEN—9 Otolaryngological operations

## UNIVERSITY HOSPITAL

*Wednesday*

GEORGE FETTEROLF and staff—2 Otolaryngological clinic, operations and demonstration of cases

*Friday*

GEORGE FETTEROLF and staff—2 Otolaryngological clinic operations and demonstration of cases

T B HOLLOWAY—4 Ophthalmological clinic

## NORTHWESTERN GENERAL HOSPITAL

*Tuesday*

M S ERSNER, H S WIEDER and M A ZACKS—2 Nose and throat clinic

*Thursday*

M S ERSNER, H S WIEDER and M A ZACKS—2 Nose and throat clinic

S H BROWN—3 Eye clinic

## PHILADELPHIA GENERAL HOSPITAL

*Tuesday*

ROBERT J HUNTER—2 Laryngology

*Friday*

L WALLER DEICHLER—9 Ophthalmology

## CHESTNUT HILL HOSPITAL

*Tuesday*

JOHN R DAVIES—1 Ear, nose and throat clinic

*Wednesday*

BENJAMIN D PARISH—1 30 Ear, nose and throat clinic

*Thursday*JOHN R DAVIES—1 Ear, nose and throat clinic  
CARL WILLIAMS—2 Ophthalmology*Friday*

BENJAMIN PARISH—1 30 Ear, nose and throat clinic

## GRADUATE HOSPITAL

*Monday*

R BUTLER G M COATES, S R SKILLERN G B WOOD  
and E B GLEASON—2 Ear nose and throat clinic

*Tuesday*

R BUTLER, G M COATES S R SKILLERN G B WOOD  
and E B GLEASON—2 Ear nose and throat clinic,  
demonstration of cases of intercostal neuralgia

## FRANKFORD HOSPITAL

*Tuesday*

FRANK EMBERY and ROBERT WATT—2 Ear nose and  
throat clinic

*Wednesday*

WILLIAM H CHANDLER—2 Eye clinic  
DR RICHARDSON—2 Ear, nose and throat clinic

ST LUKE'S AND CHILDREN'S HOMEOPATHIC  
HOSPITAL*Tuesday*

CHARLES B HOLLIS and staff—3 Ear nose and throat  
clinic

## STETSON HOSPITAL

*Thursday*

CARLE LEE FELT—12 Ear, nose and throat clinic

## ST AGNES HOSPITAL

*Tuesday*

BENJAMIN D PARISH—1 Ear nose and throat clinic

*Wednesday*

GEORGE F J KELL—2 30 Ophthalmological clinic

## CHILDREN'S HOSPITAL

JAMES A BABBITT and associates Nose and throat clinic  
EDWARD SHUMWAY Eye clinic

## WILLS EYE HOSPITAL

STAFF—2 daily Ophthalmological clinics operations and  
demonstration of cases

## NORTHEASTERN HOSPITAL

*Wednesday*

GEORGE L SHAFER—2 Sinus disease  
G A LAWRENCE—3 Ophthalmology

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## PRINCIPLES OF THE TREATMENT OF NON-UNION OF FRACTURE

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### NATURE OF UNION AND NON-UNION

**B**ONE is a connective tissue which contains specialized cells, the osteoblasts, capable of depositing, or causing the deposition of, certain lime salts. Re-union of bone fragments after fracture therefore entails, first, the same mechanism as the re-union of connective tissue fragments, and, second, the deposition of lime salts to make the union solid.

When connective tissue is severed without laceration and the two surfaces are exactly replaced, it is possible for union to occur purely by re-union of severed fibroblastic processes and proliferation of fibroblasts. This is strictly union by first intention. Actually union by first intention differs from any other union only in degree, since practically all union is brought about by granulation tissue. It is generally believed that injured serous surfaces may be united by adhesion (by means of coagulation of lymph) and subsequent proliferation of fibroblasts. In most cases, however, such union is promoted by the formation of granulation tissue.

The process of union is thus instituted by two elements, the blood vessels and the fibroblasts. When a small blood vessel, after being severed, clots and ceases to function in its distal portion, a capillary bud or sprout grows out from the active portion to carry the circulation around the obstacle. The same process is going on on the other side of the wound.

The fibroblasts meet the situation by a similar increase in activity. Severed cells are reconnected and produce new fibrous processes. The process continues: the capillary loops after reaching the surface of the wound continue sprouting, the fibroblasts multiply and send out more fibers between the loops of capillaries. The removal of the clot and debris from lacerated cells goes on at the same time. Finally, depending on the width of the gap and the speed of granulation, the new tissue from opposite sides meets and merges, the capillary loops anastomosing to form continuous vessels from one side of the wound to the other.

There is recognizable in this stimulation of growth some unknown factor which compels severed tissues to complete themselves. John Hunter called it the "stimulus of incompleteness." Severed and separated tissues will not only repair themselves but they will push out new tissue, of two varieties, in the effort to restore continuity.

After closure of the wound, the granulation tissue contracts and its vessels gradually disappear until only the comparatively avascular scar tissue is left. This marked difference between highly vascular granulation tissue and almost bloodless scar tissue has an important bearing on non-union of fracture, as will appear presently.

Non-union of wounds can occur in soft tissue as well as in bone. If two surfaces are

kept apart, as by purulent discharge in sinuses for instance, non union may come to be almost as fixed a state as non union in bone. The two surfaces become covered with dense scar which forms an effective barrier to granulation, being the end result of previous ineffective granulation tissue formation. In these cases, the attempt to establish a bridge by means of vascular sprouts having failed and further attempt being checked by the limiting avascular membrane, the "stimulus of incompleteness" is turned inward on itself, the new capillaries form loops with each other to establish venous and arterial connections and become reconciled to the situation. The vascular system under the limiting scar is as complete and settled as it is under the normal epidermis. In order to grasp the analogy between this state and non union of bone, one must realize that the ununited surfaces of the sinus are separated not so much by pus and scar tissue as by the lack of the stimulus of incompleteness, since completeness of a kind has been attained and accepted as final. Union will not occur until vascular continuity has again been broken and stimulus of incompleteness again set up. In surgical language, the wound is freshened until it bleeds.

The first stage in the union of fracture is identical with the union of soft tissue just described. Hemorrhage and coagulation between the fragments and thrombosis of the severed vessels are followed by capillary sprouting and fibroblastic proliferation to form granulations which push out until they meet.

The only difference between granulation tissue here and elsewhere is that in the bone the granulations contain the special cells, the osteoblasts. Their origin is a matter of perhaps not very serious debate. Dieterich's opinion is that they are a product of the germinal perivascular tissue. Only functionally fresh undifferentiated cells in connection with the rapidly budding capillaries could, in his opinion, be expected to work so rapidly. He thus ignores the "osteogenic" layer of the endosteum and the periosteum and points to the capillaries budding from the old blood vessels as the important factor in the regeneration of bone.

The next stages in the union of bone are peculiar to bone, and are largely concerned with the activities of the osteoblasts. The pre osseous substance is probably secreted by them, the precipitation of calcium phosphate and carbonate in this substance transforms it into bone. The deposits are in the form of trabeculae, with the blood vessels in the canals between them. In Blaisdell and Cowan's experiments, the blood clot had been replaced by a cellular and vascular growth on the fifth day, by the tenth day, callus was abundant and showed ossification with transverse trabeculae.

According to Bancroft and others the vessels of the bridging callus grow in from the medulla and periosteum, so that the new haversian canals run at right angles to the shaft. The source of the new circulation is, therefore, partly the marrow and partly the periosteum and the muscles which normally supply it with circulation or, as a sequel to the trauma causing the fracture, establish vascular connections with it. In the favorable case, these two systems of new vessels unite and carry first a vascular and fibrous bridge and finally a solid bony one across the gap. The rearrangement of the circulation and realignment of haversian canals are carried out gradually.

The exuberant callus that is laid down around the site of fracture and even in neighboring lacerated tissues is formed in the same way. Everywhere the injured vessels form granulation tissue which is rapidly impregnated with osseous material. When healing is completed, much of this excess callus gradually disappears, the lime salts and the granulation tissue being absorbed.

The transverse arrangement of haversian canals referred to by Bancroft is eventually changed to a longitudinal one. The ultimate structure of the calloused area must be similar to that of the original fragments, since it is determined by the stress in the same region. Thus the trabeculae come to present an orderly arrangement with continuous haversian canals traversing the zone where callus was originally laid down. This necessitates, and is probably in part dependent on, rearrangement of the vessels, the transverse system of

vessels in the primary callus being replaced by longitudinal haversian vessels. Restoration is not complete until the callus has assumed this orderly structure in anatomical and mechanical harmony with the rest of the bone. Until this has occurred the new structure is not completely suited to its function, and it may give way before undue strain which the fully restored structure would withstand. This, I believe, accounts for the absorption of bone occasionally observed after union has become apparently solid. X-ray examination would show that restoration has not been complete and that absorption would be avoided by proper support and braceage.

The process of union thus consists of four overlapping stages: (1) preliminary fibrous union (granulation tissue), (2) formation of soft callus, (3) formation of hard callus, (4) adaptive reconstruction of the callus.

Of these stages, only the first is clear, and even that is not always considered. Callus is often regarded as a sort of glue which is exuded, like gum from a tree, and eventually hardens into bone. The complexity of the process can be grasped only after consideration of the functions of bone and their interrelationship with other bodily functions.

*The metabolic function of bone.* While Leriche and Policard may have overstated the fact in asserting that the primary function of bone is to store calcium, they are undoubtedly right in considering that function among the most important in the economy of the body. The calcium concentration in the blood is maintained within narrow limits, elevation or depression of it beyond a definite range is not compatible with life. Since removal of the parathyroids decreases the amount of calcium in the blood and causes tetany and death, and since injection of the parathyroid principle causes increase in the blood content of calcium, it is reasonable to suppose that the parathyroids govern the calcium level in the blood, and that they are in health always active. It would follow that calcium is being constantly either released into or absorbed from the blood stream, in a manner analogous to that in which sugar is released or stored by the liver. The calcium salts in bone must therefore be regarded as

existing in the solid phase under chemical conditions which can be readily and quickly reversed to produce the soluble phase. In bone, the calcium is present as calcium phosphate and calcium carbonate. In the blood, the calcium has been shown to exist in different states, partly ionized, some of it is believed to be united with protein. The phosphate in the blood probably exists in organic form as a hexose-monophosphoric ester. In connection with the investigation of this and similar substances *in vitro*, Robison found in growing bone, and in certain other tissues, an enzyme capable of hydrolyzing the organic phosphoric acid and releasing the inorganic radical. The enzyme acted also on glycerophosphoric ester.

Two striking facts appeared from these investigations by Robison and his co-workers (10, 12, 13): the enzyme requires an alkaline medium and the curve of activity shows a marked rise around a hydrogen-ion concentration of 8.4, and the enzyme can bring about a reverse reaction, synthesis of the organic acid, under certain conditions. The enzyme, now known as phosphatase, is supposed to be secreted by the osteoblasts in the bone, how it is derived in other tissues has not been suggested. It would appear that there must be some agent in growing bone capable of producing in the fluid medium in the bone a hydrogen-ion concentration considerably higher than that in the blood or in any other normal tissue, so far as is known. The determination of the actual hydrogen-ion concentration in tissue juice presents great difficulties. Robison and Soames (13) suggest that the osteoblasts can produce a local elevation of hydrogen-ion concentration. The hydrogen-ion concentration must be considered, however, from the point of view both of its direct effect on the activity of the enzyme and its indirect effect through the solubility of the products of hydrolysis. The optimal hydrogen-ion concentration in the body might be considerably lower than that *in vitro* if the precipitation of the inorganic phosphate could be accelerated by some compensating means, such as the maintenance, by the osteoblast, of a high concentration of calcium ions in the tissue juices of bone. The product of the



concentrations of the calcium and phosphate would thus come to exceed the solubility product of calcium phosphate and precipitation would occur. Calcification would thus be the result of the co-operative action of phosphatase and the osteoblast, the former determining the concentration of the phosphate and the latter the concentration of the calcium ions.

The discovery by Martland and Robison of the synthetic action of the enzyme is of equal interest. If an excess of glycerol or glucose (or one of several similar substances) is added to the test tube after hydrolysis has gone on and inorganic phosphate has been precipitated, the phosphate passes again into solution to form the organic phosphine ester. From this experiment it may be inferred that, in the body, an excess of some such substance as glucose in the tissue juice of the bone will cause the absorption of bone salts under the influence of the enzyme. If the determination of this local increase in glucose, as well as of the alternative local increase in calcium ions, may be attributed to the osteoblasts, the alternating deposition and absorption of bone salts can be attributed to two different activities of the osteoblast, while the activity of the enzyme is determined by the purely chemical conditions as they are thus altered by the osteoblast. The governing mechanism of the osteoblast in such assumed concentration of glucose and calcium is speculative, but it may be centered in the parathyroids. If the parathyroid principle could cause the osteoblasts to increase the glucose in the tissue juice of the bone, phosphate and calcium would pass into solution, if it could prohibit the calcium concentrating function of the osteoblasts, no phosphate would be precipitated.

Robison's investigations were carried out for the purpose of determining the chemical reactions concerned in the ossification of young bone, and the conditions under which these reactions occur. They may be equally applicable to the metabolism of calcium and phosphorus as it is continually carried on. The association of calcium with protein, and of phosphorus with carbohydrate, in the blood illustrates again how interdependent the bodily elements are in their metabolism. These

considerations reveal bone as not only a complicated organ but essential to life like the liver or kidneys.

Robison makes no reference to any such possible function of phosphatase. Kay, one of Robison's co-workers, suggested that the purpose of the phosphatase in older bones "may be part of a protective mechanism, ensuring that throughout the whole life of the animal there is a slight excess of  $PO_4$  ions in the neighborhood of the already deposited bone so that inorganic phosphorus does not go again into solution." This statement is not in accord with the established fact that calcium (and therefore phosphate) is continually passing into and out of solution. Kay's statement was made before Robison demonstrated the reversibility of the phosphatase action.

The presence of phosphatase in the kidney has an important bearing on the argument. Its concentration in that organ is almost of the same order as that in bone, in contrast to the low concentration in other organs and tissues. It has been suggested by Robison's group that here the phosphatases is concerned in the elimination of calcium from the blood. If it thus has a constant function, in the kidney, related to the metabolism of calcium, it is not unreasonable to attribute to it some corresponding or complementary function in bone.

The dependence of bone metabolism or at least bone growth, on the activities of other organs is even further from explanation. The thymus, testicle and ovary, thyroid and pituitary all affect growth or ossification of bones or calcium metabolism. It may be assumed that the effect is produced indirectly.

So far as I have been able to ascertain, Robison's investigations have not been carried out on fractured bone. Some of his early work (12), however, is applicable to fracture. A long bone from a freshly killed rachitic animal was cut in two longitudinally. One half was incubated, as a control, in normal saline, the other in a solution of calcium hexosephosphate. In the control, the osteoid substance thrown out by the cut surface contained no lime salts on histological examination. In the other half, dense deposits of calcium salts were found in the osteoid. Robison used this exper-

iment to demonstrate the hydrolytic effect of phosphatase on the organic soluble phosphate. Since he has found no less phosphatase in rachitic than in normal bone, he assumed that the rachitic manifestations were attributable to some failure of the supply of organic phosphate. His conclusions in this regard have no immediate reference to the subject of this paper. It will be observed, however, that Robison had produced conditions which do not obtain normally; he was experimenting with traumatized bone, and neither at that time nor in a later experiment (13) did he have a non-rachitic traumatized bone as a control. The experiment may equally well be used to demonstrate the ability of the osteoblasts and phosphatase to calcify callus in a traumatized bone, provided there is an ample supply of the substrate. It will also be observed incidentally that, in the experiment, the bone is cut off from the direct influence of the parathyroids. Robison's results may fairly be applied to the reaction of bone after fracture if the supply of the substrate is maintained (by adequate blood supply), the callus will calcify, if circulation is defective it will not, and the positive effect requires the presence of phosphatase. The further application of the experiment to the behavior of the bone graft is interesting if not yet quite justifiable. It constitutes, at any rate, a partial refutation of the contention that a bone graft dies and is absorbed, and it supports the argument, which I shall presently advance, that speedy establishment of vascular connection with the graft is essential to the proper supply of the soluble phosphate (and calcium) necessary to consolidation of the union of graft and host.

It is not too much to assume that the deposition of lime salts in the granulation tissue at the line of fracture is controlled by the same mechanism that brings about ossification in a young bone.<sup>1</sup> It is true that the amount of phosphatase decreases after developmental ossification is complete, but the newly formed osteoblasts in healing bone, whether produced by proliferation of those of neighboring bone or by metaplasia of fibroblasts, might be ex-

pected to possess increased potentiality for the manufacture of phosphatase. At any rate, it is more reasonable to believe that the increased osteogenetic potentiality of bone after fracture consists of increased manufacture of phosphatase, both for hydrolysis and synthesis, than to attribute it to the much debated increase in the calcium and phosphorus content of the blood. Increase in these elements, if it does occur, loses much of its importance when considered with the complex processes of bone metabolism.

The calcium phosphate and carbonate are laid down in the pre-osseous substance, presumably under the influence of the phosphatase, under chemical conditions governed by the osteoblast. Whether the lines of stress produce a pattern in the pre-osseous substance, as Leriche and Policard suggest, whether the law of colloids under pressure is applicable, or whether stress has a direct effect upon the action of the osteoblast, the result is that the new bone is laid down in trabecular formation, leaving the vessels in canals at right angles to the axis of the bone. Robinson (11) considers that the formation of trabeculae depends upon the accidental arrangement of the vessels of the callus. Whether this is so or not, the rearrangement of the trabeculae to conform to the stresses of function cannot be explained so simply. It would not help the argument to endow the vessels with adaptability to stress. Whatever the fundamental explanation, this rearrangement of trabecular structure must be immediately effected by the osteolytic and precipitating activity of phosphatase following changes in the constitution of the substrate in adjoining zones of bone either synchronously or at alternating intervals. It is futile to expect at this time to translate into terms of chemistry these reactions of living tissue to environment.

*Non-union of fracture.* Theoretically, non-union might result from the failure of any one of the stages of union, practically union is more likely to fail at some stages than at others.

1. The granulation tissue may fail to bridge the gap (a) because of the interposition of tissue which the granulations cannot

<sup>1</sup>In conjunction with the Biochemical Laboratory of the New York Post Graduate Medical School I have undertaken the investigation of the concentration of phosphatase in bony material derived from cases of fracture and of non union.

penetrate, (b) because the fragments are so displaced that the two areas of granulation cannot meet, (c) because too extensive removal of blocks of living bone after fracture has left the fracture surfaces too far apart.

2 The granulation tissue may degenerate into scar tissue before ossification has been established. If the formation of the granulation tissue is slow and its nutrition is not well maintained, the stage of contraction is likely to be precipitated. The osteoblasts under such circumstances are poorly nourished, and they multiply slowly and secrete pre osseous substance and phosphatase slowly, sufficient lime salts cannot be deposited to bridge the gap before the stage of contraction of the granulation tissue sets in.

3 The early granulation tissue may be so disrupted by manipulation, or inadequate immobilization and the stress exerted on them by the muscles after recovery from anæsthesia, that the process of capillary budding ceases or becomes inadequate for the needs of connective tissue union and ossification. As Kellogg Speed puts it, "the vascular outgrowth is disrupted, disheartened, and ended." Robinson (11) discusses the danger of movement of the fragments and its effect on granulation tissue. He shows how opposed to the physiological principles of union Lucas Championnière's teachings were in this regard.

4 Similar disorganization may be produced by rough manipulation after the formation of soft callus. While nature may be expected to persist in spite of her first efforts having been undone, it is probable that in cases unfavorable for other reasons, the effort will not be repeated. When such trauma results in the rupture of vascular continuity between intact bone and a large mass of granulation tissue or soft callus, these become actual obstacles to union until vascular continuity with them can be re established. In essence, a comminuted fracture now exists. If the fragment of new tissue is displaced, it may constitute an insurmountable obstacle.

5 Since blood may be brought to the area of fracture by periosteum (from the muscles), by the nutrient artery, through the marrow and by the haversian system, it is not likely

that all sources will fail. If the laceration of muscles is so great that the perosteal circulation is diminished, or if the nutrient artery is ruptured, or if the pressure of excessive hæmatoma or congested soft tissue on the area of fracture is so great as to impede the circulation to it, any one of the other causes may be sufficient to defeat the efforts at union.

6 Infection is a cause of non union the influence of which has, in some respects, been much discussed. Local acute inflammation of certain types is a stimulus to the formation of granulation tissue and even of callus. One has observed the stimulation of union following erysipelas about a compound fracture. Still, the destructive effect of infection on callus and formed bone is not to be disputed. When inflammation results in extensive thrombosis, necrosis must ensue in bone as in any other tissue.

A destructive type of low grade infection is often associated with the presence of foreign bodies in the fracture zone. It is a common experience to find pus about metal plates and extending between the fracture surfaces. In such cases, if granulation tissue has been thrown out by the bone elements, it has been destroyed and no evidence of beginning union is evident.

7 Lane's plates, especially when incorrectly applied, may cause non union. At best, the necessary stripping of the soft parts leaves the ends of the fragments isolated and impairs the circulation especially to the periosteum. The ends of the fragments are thus robbed of nourishment and may even be devitalized. If the bone ends are distracted, the stimulation of mutual opposition and fracture surface stress is lost, moreover, the greater the distraction, the wider the space to be filled with granulation tissue and the greater the danger of the connective tissue contracting to form avascular scar tissue before ossification is complete. The proneness of low grade infection to set in, in the presence of foreign bodies, has been referred to. In a surprising number of cases when removing metal plates in non union, I have observed a thin, seropurulent fluid (due to the foreign body irritation) between the fragments and I have considered such exudate a serious

obstacle to the formation of granulations and to ossification

8 A rarer cause of non-union is absorption of solid callus before restoration of trabecular alignment has been completed. Manual examination of the site of fracture, even the X-ray study of it, may reveal no occasion for caution. If more function and stress are permitted than the new bone can accommodate itself to, the new structure may be absorbed. Since this accommodation consists of the absorption and reconstruction of trabeculae and rearrangement of the vessels of the bony system through the callus, and since these depend upon the abundance of blood supply, it is clear that, if vascularization is restricted or circulation impeded, absorption of callus is more likely to occur when function and stress are permitted. It is one of the purposes of massage to ensure circulation proportionate to the demands of the stress of early function.

The reparative response after fracture seems strikingly independent of systemic conditions. It does not vary directly with the general state of health, nor is it affected, with any constancy, by diseases characterized by malnutrition or general debility. There is a general feeling that old age must cause inhibition of bone growth. This is not clinically a fact. Bones of aged people seem to unite with the same facility as they do in the young. By all odds the most stubborn non-unions are in the infant or young child, particularly if the fracture was intra-uterine. Some surgeons of considerable experience have gone so far as to recommend amputation in all cases of intra-uterine fracture. My statistics show that in such cases, by instituting operative treatment in conformity with the physiological and biological principles of bone repair, I have succeeded in inducing union in about 60 per cent.

CASE 1 This child was 9 years old when I first saw her. The diagnosis was congenital pseudarthrosis of the left tibia and fibula. At the age of 3 or 4 years a graft taken from the father's leg had been applied, but the child fell off a chair and broke it. A second graft from the father's leg was tried when she was 5. The complete failure of these attempts is shown in Figure 1 A.

I used an inlay graft from the patient's sound tibia. The result 2 months later is shown in Figure 1 B. I tried having the child walk with a brace, but 5 months later it was clear that union would not occur. I operated again, using an inlay graft and two silver grafts from the other tibia. Five months later union was solid (Fig. 1 C and D), and the child was walking with a brace. At the latest report, nearly a year after the operation, the leg was still firm.

In this case a homogenous graft had been used twice. This should never be done unless an autogenous graft is not available. In the latter case the donor and recipient should be of the same blood-type.

CASE 2 This was a case of intra-uterine fracture of the left tibia and bowing of the fibula. Various operations had been performed but union was never permanent. Wiring and bone grafting had been tried, both separately and in combination. Figure 2 A and B illustrate two of these attempts when the child was 3 years old. I saw the child when she was 6, the non-union and bowing are shown in Figure 2 C. I used a double wedge end inlay graft taken from the child's other tibia. I also performed osteotomy to straighten the fibula. Figure 2 D and E (taken a month apart) show the result 2 years later. Four years after this operation, the child was reported to be as active as the normal child, and it was considered that functional restoration was complete.

Five years after the operation, the child slipped and the tibia fractured in its lower third. Reunion was effected by the use of a plaster splint, but re-fracture occurred 3 months later. Plaster splinting again brought about union. The condition 7 years after the operation is illustrated in Figure 2 F. Now, 14 years after operation, the function of the limb is excellent and union is solid.

This was Dr. Clarence William's case. He performed the early operations but finally became discouraged and kindly referred the case to me. The case illustrates how necessary it is for the surgeon to be able to apply immobilizing splints and apparatus, not only immediately after operation, but during convalescence.

The causes of non-union may be grouped into those concerned with the formation of granulation tissue and those concerned with the ossification of that tissue. Bancroft makes so little of the second group of causes that he states "If a fracture is immediately treated in a manner which will replace as far as is feasible the fractured ends in suitable opposition and allow for organization of the clot and ingrowth of granulation tissue with its accompanying vessels, repair will inevitably follow." Clinical experience in cases of multiple fracture supports Bancroft's belief that the causes of failure of union are local, one fracture may

unite and another fail. Still, I would not make so sweeping an assertion as Bancroft's. It is true that investigation of one systemic disturbance, that of the calcium and phosphorus content of the blood, has been inconclusive, but since, as I have pointed out, non-union may be the result of failure of the preliminary stages of healing and may thus have no connection with ossification, conclusions from observations of a mixed group are of necessity contradictory and erroneous.

The end result in non union varies with the fate of the granulation tissue. If it has formed a complete bridge but has degenerated into fibrous tissue there may be a dense mass of scar tissue between the fragments, constituting fibrous union. If it has been largely destroyed by pressure and movement of the fragments, the space it occupied may be filled with a pseudo synovial fluid enclosed in a capsule which represents the peripheral portion of the original granulation tissue. This is the pseudarthrosis. In other cases there is no evidence that granulation tissue ever bridged the gap the fragments being entirely displaced and disconnected.

#### GENERAL PRINCIPLES OF TREATMENT

*Non operative measures.* In a general way, it is to be expected that measures directed to the improvement of general health will aid bones to unite. The relationship of general health and vigor to the process of union has already been discussed. We do not know what forms of organic food are most beneficial but we assume that foods containing more calcium and phosphorus are to be prescribed, although there is in the bones an ample reserve of these substances awaiting mobilization by the mechanism that normally governs calcium metabolism. There is nothing specific therefore, in the dietary treatment in fracture cases. The direct administration of calcium and phosphorus I consider unwarranted scientifically, and probably useless.

The same may be said for ultraviolet light and irradiated sterols. Certainly ultraviolet light can have no direct local effect, since the ray can penetrate such a slight distance. It has been suggested that calcium and phosphorus are ionized in superficial tissues, and

that electrical modifications in the proteins of the skin cause changes in the hydrogen ion concentration. The most likely explanation of the value of ultraviolet in the treatment of rickets and malnutrition is that the energy is absorbed either by cholesterol or by fluorescing materials in the skin and carried by them to regions where the energy can be used to induce chemical change. The effect of these methods in the treatment of rickets is no criterion of their value in ununited fracture, there is no proof, or even indication, of resemblance between the two conditions. Nor does the fact that lack of ultraviolet light (and of vitamin D) leads to failure of calcification furnish proof that failure of union is due to such deficiency, or that administration of them in excess will promote union or even calcification. Bancroft's opinion of the requirements for union, already quoted, and the growing belief that the causes of non union are local shake one's confidence in all general measures. Kellogg Speed apparently agrees with Bancroft's statement, yet he recommends general measures in considerable variety: the ultraviolet ray if the patient is septic, a high protein diet, vegetables, and milk. There is only the vaguest reason why ultraviolet should counteract sepsis, the high protein diet is presumably based on Clark's demonstration of increased rate of healing of wounds in a dog when the diet was entirely protein.

Even if it is granted that a high protein diet will accelerate the formation of granulation tissue, one must consider the possible effect of diet on calcium metabolism. A potential acid diet may increase the elimination of calcium to a marked extent, and it is probably of greater importance that the diet be neutral or of low potential acidity. If it is not, then food rich in calcium should be added. The question of diet is still in the hands of the physiologists. The most unlikely remedy is parathyroid extract, which has been injected because it increases the calcium content of the blood, even though this is at the expense of the calcium in the bones. There is nothing in medicine that more aptly illustrates the danger of a little knowledge. Speed is not by any means alone in prescribing

ing phosphorus, although its only known effect on bones is to cause their necrosis. The effect of large doses is no proof of the effect of a small one, but the contrast illustrates how much speculation there is behind all of these general measures. Although it would be unwise to discourage attempts to put new discoveries to the therapeutic test, one must admit that, in many of our efforts, we have strained if not violated these principles and have leaped without our eyes clearly open. I do not believe that, at the present time, one can recommend any specific medication or dietetic treatment.

In cases of delayed union, it is often desirable to use the limb, carefully protected by braces against lateral stress. The pressure of the fracture surfaces on each other will stimulate osteogenesis if there is any source of granulations and of osteogenetic cells in the vicinity. In well established non-union and in frank pseudarthrosis, the fracture surface is quite incapable of making any response of either kind.

Speed discusses Bier's hyperæmia and Thomas' pounding method and tries to establish some physiological justification for them. Nobody has ever explained why congestion with sluggish circulation, induced by trauma or otherwise, should supply more nutrition or calcium salts than free normal circulation. Stasis must depress local metabolism, and there is no agreement on the effect produced by an increase in the hydrogen-ion concentration of the blood in stasis. Robison's phenomena occur at a low hydrogen-ion concentration. These chemical reactions must not be detached from their physiological background, one must remember that ossification takes place in a specialized tissue the existence and physiological activity of which constitute the first requisite of callus formation and bony union.

The pounding method of Thomas is not to be explained on a chemical basis and not to be justified on any basis. It is at best a crude and blind method of freshening tissues at the site of non-union, it may result in the formation of fresh granulations which may carry a bony bridge from fragment to fragment.

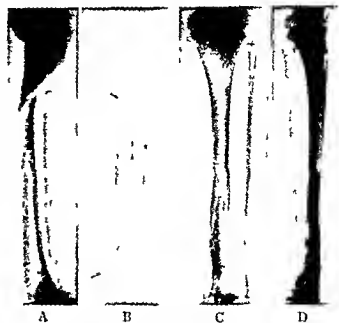


Fig 1 Use of the bone graft in a case of intra-uterine fracture of the tibia and fibula (Case 1). A shows the failure of a homogenous bone graft. B illustrates the result of author's first attempt with an autogenous graft inlaid into the tibia. C and D are two views 5 months after the insertion of a second autogenous graft which was successful in promoting complete union.

**Operative measures** There is only one way to treat non union and that is by open operation. The site of fracture must be carefully exposed so that the conditions inhibiting union may be recognized and suitably dealt with. As time has gone on, the importance of vascularization has been so much impressed on me that I have entirely changed my attitude to the ischæmic scar between and around the ends of the fragments. I now remove not only all such, but scar in the neighboring soft tissues as well, so that circulation may be restored and the fragments revitalized. Non-union is a most stubborn condition because it is a fixed end-result which nature has accepted in lieu of the normal, the stimulus of incompleteness has ceased to act. The operative measures instituted should be those which the surgeon believes will be most likely to result in union. It should go without saying that, in accordance with surgical principles, he will not be satisfied with anything short of his best effort. In no other branch of surgery, so far as I am aware, has any attempt been made by a responsible surgeon to justify methods which can admittedly succeed only occasionally, and to condemn other methods

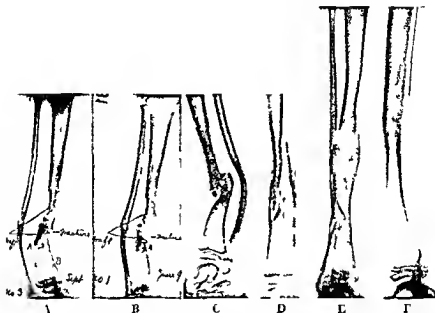


Fig 2 Case of intra uterine fracture of tibia and fibula (Case 2) A and B show the results of bone grafting and wiring C shows the condition at the time of first observation D and E were taken 2 years after the insertion of a double wedge end graft and osteotomy of the fibula by the author F shows the ultimate result 7 years after traumatic fracture and subsequent union brought about by splinting



Fig 3 Progress of a case of gunshot wound with infection and loss of substance of the tibia (Case 3) A shows the original infected wound B C and D ineffective attempts at bone grafting with material taken from the fibula and elsewhere The firmness of the fibular graft is evident in C E shows the result 7 months after the author's insertion of an inlay graft from the sound tibia It is now a year since the operation and the leg is functioning normally

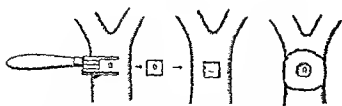


Fig 4

Fig 4 Method of removing graft consisting of bud with portion of bark and alburnum and fixing it in a gutter in the host. The double bladed knife, like the twin motor saw, insures accuracy of fit. The paraffin dressing provides immobilization and access to light.

Fig 5 Method of preparing graft bed and inserting graft. The longitudinal section shows the graft in place, each element making close and intimate contact with a similar layer in the host. The nutrition of the graft, diagrammatically represented, comes from the marrow and periosteum of the host. (The linking up of the two vascular systems by means of granulation tissue cannot be represented because of the microscopic size of the granulation area between host and graft.) The cross sections, one through healthy bone and the other through sclerotic bone, show the difference in vascularization at these two levels. The right and wrong ways of using the twin saw are represented below.

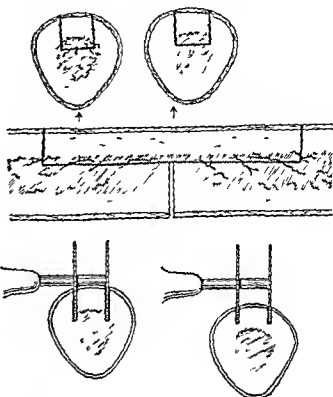


Fig 5

on the ground that "reasonable" exactness will usually suffice. If a surgeon were satisfied that the method of drilling the fragments



Fig 6 Use of a sliding graft for non union of tibia (Case 4). Non union of both tibia and fibula with displacement is shown in A. The sliding graft ultimately used is seen in B and C. The result 3 months after the operation is shown in D and E. Note the filling in of the cavity left by removal of the sliding graft. Some constant of the operation, possibly the immobilization of the tibia would appear to have stimulated osteogenesis in the fibula.





Fig 7 Use of a long inlay graft following marked destruction by osteomyelitis (Case 5). The 6 inch gap in the tibia is seen in A. The inlay is illustrated in B taken 4 months after the operation. Subsequent fracture of the graft seen in C united when the limb was supported with a brace. Not only re union of the graft but marked enlargement of it are evident in D.

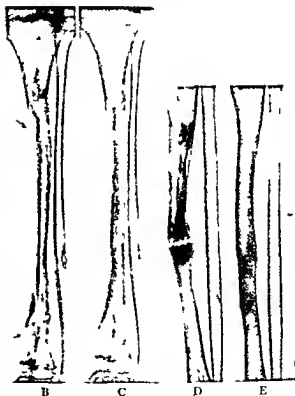


Fig 8 left Inlay graft in a case of gunshot wound with loss of substance (Case 6). The non union with little sign of callus is seen in A. The result 4 months after the operation is illustrated in B. Callus can be seen about the graft.

Fig 9 Case illustrating operative treatment of fractured graft (Case 7). Osteomyelitis had resulted in con-

blindly through a small incision was the utmost that could be done for the patient, I should have no criticism to make, it is the advocacy of nibbling tactics that one finds so disturbing and so subversive of sound surgery. In the series which I shall presently review, prior operations, much more commensurate to the needs of the case than this one, had been performed in 42 per cent, with failure, and often repeated failure, in all.

To show the inconsistency between clear appreciation of surgical principles and the way these principles are applied to practice, I quote two passages from an article in one of our best surgical journals, "Even slight too early motion after a well planned and executed operative treatment may militate against a successful result", and "Too rigid, too extensive or exaggerated methods of internal splints are not often required." How can



siderable loss of substance with a hiatus between the fragments. A. The result 4 and 8 months after the insertion of an inlay graft is seen in B and C. The wedge ends of the graft can still be seen in B. Fracture of the graft 2 years later is evident in D. Treatment by means of sliding graft taken from original inlay and result are illustrated in E.

fixation be too rigid? Certainly for those of us not endowed with sufficient vision to select the cases in which slip shod methods will suffice, there is only one course we must use the most exact technique and the most precise methods that the unfavorable case would demand

In the treatment of non-union, surgeons adopt methods varying from the purely mechanical to those which are based on the most accurate conception of the process of union which physiology and biology can supply. In between the two come various methods which violate one or more of these fundamental principles one sacrifices immobilization, another takes no account of the necessity for optimal vascularization, according to another, boiled bone is a graft or differs in virtues and drawbacks from other inanimate foreign material



Fig 10 Metallic reles of four different operations which had the mechanical aim of promoting union and the physiological result of preventing it

The surgeon who is the greatest menace to progress is he who while admitting the unsoundness of his methods, persists in them because his results, although not satisfactory, are better than he can obtain with a technique that is physiologically superior. General sur-



Fig 11 Failure of intramedullary graft and success of an inlay in the tibia (Case 8). The failure of union after non operative treatment is illustrated in A. The intra medullary graft is seen in B which shows also the extensive reaming out of the marrow and the destruction of it produced by manipulation of the graft in making it engage both fragments. Note shortness of graft indicated by arrows. The author's inlay is shown 2 months after the operation (C and D) and 1 year after (E and F).



Fig. 12 Failure of onlay graft following failure of an intramedullary graft (Case 9). The defective immobilization and uncertain contact of the intramedullary graft are clearly exemplified in A. Apparent success of the onlay applied by the author is seen in B. It eventually fractured and loosened and was replaced by an inlay.

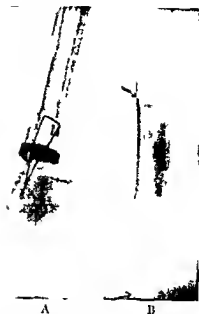


Fig. 13 Failure of the Senn operation followed by successful application of the inlay graft in the humerus (Case 10). The net result of two previous operations is suggested in A. The metal remains and union has failed, but there is only a general indication of the shortening actually produced by intent and injudicious application of metal. Proliferation of the inlay graft is evident in B.

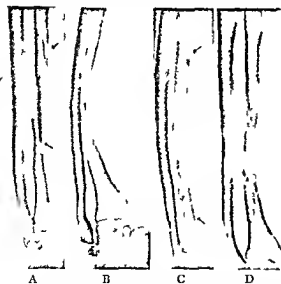


Fig. 14 Incorrect and correct methods of inserting a graft into a smaller long bone (Case 11). The almost inevitable disaster awaiting the attempt to put an intramedullary graft into the radius is illustrated in A, which shows fracture of one host fragment, and in B, which shows the later absorption of the radial fragment and of the graft. The successful application of the double wedge end graft is illustrated in C. D shows the thorough amalgamation of the graft 2 months later.

gery has passed this stage, its progress has gone on hand in hand with progress in physiology and biology. It has sometimes gone in advance of physiology and demonstrated phenomena that the physiologists must explain, but it has never gone counter to well established scientific principles. The

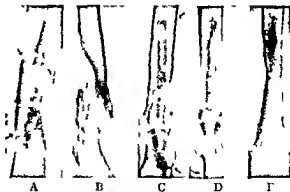


Fig. 15 Destruction of graft into humerus by recurrence of infection. Inlay of second graft in original inlay (Case 13). The attempt at grafting and the condition at the time of first observation are shown in A and B. The author's first inlay, C, was destroyed at its central portion by infection. D, The second and successful inlay into the remnants of the first is shown in E.

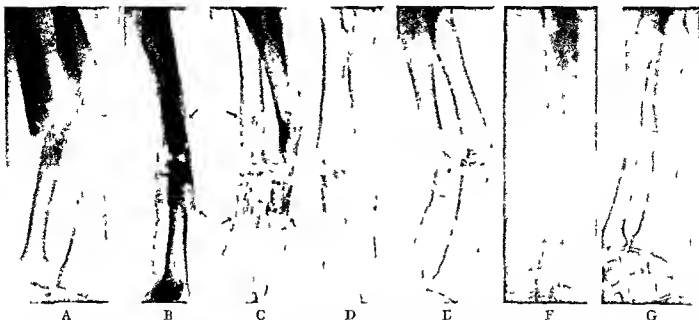


Fig 16 Successful use of the double wedge end inlay graft after the failure of many operations (Case 14) The early condition is shown in A Failure of bone grafts is seen in B, C, and D, taken over a period of 8 months The roent

genogram in E was taken 10 days after a later suturing operation following extensive removal of bone The result 6 months after the double wedge end inlay operation by the author is illustrated in F

treatment of goiter is applied physiology, postoperative tetany was clearly explained by the physiologists Intrathoracic operations

have been made possible only by the elucidation and better understanding of the physics and physiology of respiration



Fig 17 Successful use of double wedge end inlay grafts in non union of the radius and ulna (Case 15) The original non union is seen in A, the roentgenogram in B was taken 3 months after the insertion of the double wedge end inlays The arrows at a and b indicate the sliver grafts, the others point to the ends of the inlays

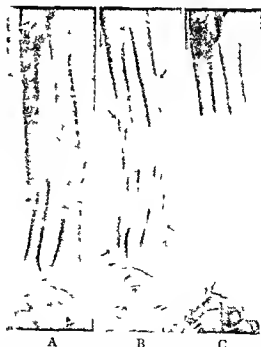


Fig 18 Prompt union following the use of double wedge end inlays in a case of non union of radius and ulna at the age of 63 (Case 16) The non union is shown in A the result at intervals after the operation is illustrated in roentgenograms B and C

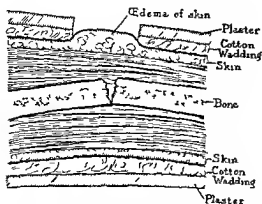


Fig. 22 Diagrammatic longitudinal section of a limb in plaster with a window to show the displacement of the fracture fragments produced by the unequalized pressure and the protrusion (and consequent edema) of the soft parts through the opening

which needs the ultraviolet for the metabolic activity of its chlorophyll

Plant grafting and bone grafting thus have the same objective and are carried out according to the same fundamental principles. The application of these in bone must be more meticulous since there are added difficulties in a relatively highly specialized tissue nourished by a system of closed vessels.

In the plant the only force to be counteracted is that of the wind, and this only when the scion is a large shoot. In bones there is the pull of muscles, both tonic and voluntary, and the exaggeration of the former by reflex from pain. Fixation and immobilization, therefore, present difficulties which must be met in a special way.

Bancroft's statement in regard to union of fresh fracture is even more applicable to the union of the bone graft. "The most important factor for the union of fracture is to have the fractured ends in close opposition and to have an adequate blood supply to allow the ingrowth of granulation tissue with the resultant ossification to form callus." Adequate blood supply and coaptation are even more necessary in the case of the graft, because the stimulus which recent fracture gives to osteogenesis is lacking in the old fragments. In the fresh fracture, there is usually an adequate blood supply in marked contrast to the ischemic state of a pseudarthrosis. Union of the graft, therefore, proceeds under difficulties

that must be counterbalanced by the most careful methods in its application.

**Vascularization of the graft.** Just as the union of fracture fragments is fundamentally similar to that of severed soft tissues, so the union of bone grafts with the host is similar to that of fascial or tendon grafts. It has not been shown that in either of the latter the graft is replaced by overgrowth of local tissue. Garlock investigated the stages of union and the fate of a tendon graft. "The experiments reported in this paper show definitely that the graft lives as such." His description of the nutrition of a tendon graft may, with suitable changes, be applied to that of a bone graft. "It is probable that the graft derives considerable nutrition from the tissue juices. It is probable that the main source of nutrition is from the outgrowth of young capillaries and lymph vessels from the tendon ends and from the subendothelial tissues of the sheath."

The various layers of a bone graft freshly removed present raw surfaces wherever they have been cut. The vessels are severed but still contain blood which tends to clot at the point of section. The various tissues of the graft are capable of survival for a considerable time, but it is of the first importance to restore its blood supply and nutrition. The graft must be placed in the most favorable environment for this end (Fig. 5). If it is so placed that the elements of the graft (periosteum, cortex, endosteum, and marrow) make direct and intimate contact with similar elements in the host, the soft tissues of the bone first unite across the slight gap, vascularity of host and graft is re-established through periosteum, endosteum, and marrow, and a granulation tissue bridge is laid down between the bony surfaces. Osteoblasts appear in the granulation tissue and determine the deposition of lime salts. If the process follows Bancroft's picture of healing bone, the continuity of the Haversian systems will be indirect until the normal architecture has been established between the graft and the host. Under ideal conditions, the greatest possible number of capillaries of host and graft are brought into the closest mutual approximation. The graft will then remain intact. If such conditions are not provided smaller or

larger areas of the graft will fail to be nourished and will ultimately be replaced. The process by which the bony structure of the graft is later rearranged to conform to the structure of the host is in no sense absorption. The process can be called assimilation, if the term is used in the sense that the graft assimilates itself to the host. The graft is not the subject of processes imposed upon it by the host, it is itself the active agent in its own rearrangement under the influence of the stresses which it encounters in its new environment, it has the power of adaptation.

If all the elements of the graft cannot be brought into contact with similar elements of the host, the marrow at least should be. Johnson's conclusion that the circulation was re-established, 75 per cent by the marrow and 25 per cent by the periosteum, indicates the share which each tissue has in osteogenesis.

That the blood supply is the key to the situation is shown by certain clinical observations. When a large anæmic scar surrounds the region of non-union, it is admittedly good practice to replace the scar with a pedicled skin graft laid right on the ununited fragments. Union occasionally follows such preliminary treatment. In any event, the chances of union are much enhanced by the methods which improve the circulation to the tissues adjoining the non-union and through them to the periosteum of the fragments and of the graft, if one is inserted. Correspondingly, the chances are diminished by interference with the circulation to the graft. The original fracture may have been accompanied by laceration of tissues, such as tendons and nerves, which still demands repair. The operations should be taken in order of their urgency, and the success of the bone graft should not be jeopardized by another operation performed at the same sitting. Extensive dissection not only necessitates prolonged exposure of the wound to the air but interferes with the circulation to the soft parts. Many of the smaller blood vessels are severed or occluded as the result of the trauma. Tissues in this state constitute a very unfavorable environment for the bone graft.

**CASE 4.** In this case, both tibia and fibula had been fractured, at the junction of middle and lower

thirds, 3 months before I saw the patient. A cast, followed by a brace, had proved ineffective, and non union was evident (Fig. 6 A).

Believing that lack of osteogenesis had not been shown, I brought the fragments into apposition, mortised them, and sutured them with kangaroo tendon. The failure of union, evident on removal of the cast 2 months later, indicated that osteogenesis was not vigorous, and the failure of massage and the use of a brace to promote union confirmed this conclusion. Accordingly, 6 months after the first operation, I made use of a sliding graft. In Figure 6 B and C show the result 2 months later and D and E at the end of the third month. Union by this time was solid and the result is still excellent 9 months after the operation.

This case illustrates the point that the fibula is usually ignored in fracture of the lower leg. I have never put a graft into the fibula. It was quite clear that the fibula was out of place, but the questionable advantage of repairing it was quite outweighed by the disadvantage of interfering with the circulation in the vicinity of the tibial graft. Nothing should be allowed to prejudice the success of the main effort, which in this case was repair of the tibia. For this reason I have never attempted to develop nerve ends or to repair lesions of nerves in the zone of fracture. Such operations should be undertaken either some time before the graft is inserted or long enough after it for the trauma and vascular disorganization to have no prejudicial effect on the vascularization and union of the graft.

When the fragments of a non-union are osteoporotic, the chances of union, instead of being diminished, are actually increased. Osteoporosis is associated with increased vascularity, and this must account for the rapidity of union of a bone graft in such cases. True, a sliding graft (from one of the fragments) may be so flexible as to afford poor immobilization, and an autogenous graft from some other region may be little firmer, but the graft will unite readily because of the abundant blood supply.

*Relation of coaptation to union.* The approximation of graft to host is analogous to closure of a wound in soft tissue. If the opposing surfaces are poorly approximated, much granulation tissue is required to fill the gap, and healing is slow. If the surfaces are brought into close contact, the layer of granulation tissue is of microscopic thickness and healing by first intention results. This speedy granulation tissue union not only re-establishes the circulation in the graft at the earliest moment, but results in the deposition of the

thinnest possible layer of callus between the bones. This necessitates the least possible rearrangement of the callus trabeculae. It is thus evident that not only the viability of the graft but the promptness and durability of union and the rapidity of assimilation of the graft to the host tissues depend on close approximation of graft to both host bones. In non union, the surgeon will find that nature has little callus for him and he must make the most of the meager supply, he must draw on mechanical principles to compensate for the meagerness of the physiological reaction.

When a graft containing all four elements is placed in intimate contact with the same elements in the host, it acts as a vascular and osteogenetic unit, vascular union proceeds along the lines of natural repair and a bridge is placed between the two fragments which calls for the minimal amount of trabecular and vascular readjustment to take on the function of the host bone it replaces. If the graft is inserted or attached in any other way, vascular communications are limited (and the viability of the graft thus jeopardized) and the graft may have to be largely or entirely reconstructed by nature before it assumes the structure suitable to the stresses exerted on it. It is under such circumstances that absorption occurs.

*Relation of immobilization to union.* When soft tissues are uniting, their flexibility minimizes the danger of disruption of the granulations. When such rigid tissue as bone is uniting, the least displacement may tear the granulations and blood vessels or fracture the soft callus. Hence the necessity for the most accurate and stable immobilization. From the mechanical standpoint, the advantage of "internal" immobilization needs no proving. Here again the inlay graft is superior. It exemplifies the mechanical principle of the slot and key.

When the healing fragments and the graft are thus held in rigid immobility, the granulations and callus are protected not only between graft and host but between the two host fragments. The stress of maintaining immobility falls on the graft and, under this influence, the graft grows in size and strength (in accordance with Wolff's law) and adapts its

structure to the stress. A graft the size of a pencil, when inserted into the femur, will grow to the dimensions of the host bone and assume an identical structure, by its power of adaptation.

To illustrate the ability of a graft to replace lost bone, even up to the major portion of the shaft, I present 3 cases in which either because of old osteomyelitis or gunshot wound, there was extensive loss of substance. These may not come strictly within the scope of the paper, but it is hoped that consideration of them (particularly Case 5) will dispel the notion that there is any place in practical surgery for the conception that the bone graft is a mere scaffold of transient value and doomed to absorption.

**CASE 5.** The patient was a girl 8 years old. Two years before osteomyelitis had necessitated the removal of 6 inches of bone from the left tibia. The condition when I saw her is illustrated in Figure 7 A.

The appearance of the graft, 4 months after the inlay operation is shown in Figure 7 B. A few months later the graft fractured as is shown in C. The patient was given a brace and the graft reunited without trouble. The roentgenogram (Fig 7 D) shows not only solid union but marked growth of bone in the graft. It is now more than 8 years since the operation and the graft has given no further trouble.

In this case a great deal of bone had been lost and was successfully replaced by a tibial graft. The limit to the length of the graft is determined only by the length of the bone it is taken from. The case also demonstrates the probability that the fractured graft will reunite if adequate immobilization is provided. If, as occasionally happens it does not reunite even then a graft may be placed in the original graft as is illustrated in Cases 7 and 13.

**CASE 6.** This case illustrates the use of the bone graft for loss of substance following gunshot wound in an adult. The accident had occurred during a hunting expedition. There was much laceration of tissues and troublesome hemorrhage. Infection and sequestration occurred during the early course. The former was controlled by the Carrel Dakin treatment and the wound healed after 9 months. Considerable bone had been lost and many shots were scattered through the soft tissues when I first saw the patient. Non union was present and there was little evidence of callus formation (Fig 8 A). No attempt at surgical repair had been made and no fixation had been provided except by splinting.

I bridged the gap with an inlay bone graft from the patient's tibia. Figure 8 B shows the result 4 months later. Callus formation is evident about the graft. It is now 8 months since the operation and the graft is still solid.

I made no attempt to remove the shot. Foreign bodies with no infection about them can be left, it is a mistake to attempt the impossible. Nothing may be gained and much may be lost by interfering needlessly with the circulation when a graft is inserted (see discussion of Case 4).

CASE 7. In this boy of 12 years, loss of substance had followed osteomyelitis of the left tibia 2 years before. After operation and prolonged drainage, the wound had healed in 6 months leaving a gap of 2 inches in the tibia (Fig. 9 A).

I used an inlay graft from the sound tibia. The result 6 months later is illustrated in Figure 9 B. About 2 years later the patient broke the graft (Fig. 9 C). (This roentgenogram was taken a few weeks afterward.) About 2 months after the fracture, I used a sliding graft from the original graft, with an excellent result (Fig. 9 D). Five years after the last operation the result is still splendid.

In this case the sliding graft for the second operation was entirely supplied by the original graft. Nothing could better prove the vitality of the original graft more than 2 years after it had been inserted. Fracture of the graft is not the common result, these cases are presented to show that it will unite again and that it has vitality and osteogenetic power.

*Necessity for power driven tools.* The entire process of union and the survival of the graft depend on the establishment of vascular connections between the graft and the host fragments, the rapidity of establishment and the degree and permanence of vascularization vary directly with closeness of coaptation and rigidity of immobilization, these depend on accuracy of fit. The necessity for the greatest precision in the mechanical procedures needs no further argument, ideal conditions can be produced in no other way than by the use of automatic, power driven tools which can be adjusted to cut with mathematical exactness both the graft bed and the graft which is to fill it.

Fortunately, all bones are filled with cancellous tissue or marrow and are thus well suited to the inlay technique. The universally adjustable twin saw which I designed 20 years ago serves ideally, as similar tools have served similar purposes in the industrial world.

*Relationship of mechanical, physiological, and biological principles.* The most unfortunate and the most general misconception of the treatment of non union is that it is a mechanical problem. The idea is inherited from the principles of the treatment of fresh fracture. The traditional methods are based entirely on

mechanics how to overcome distorting forces and how to maintain alignment by the application of counter forces or stress. If, after reasonable reduction and immobilization of the fragments, union fails, the problem passes from the realm of mechanics into those of physiology and biology. It is not to be expected that repetition of mechanical methods will be successful, since the stimulus to granulation and ossification has abated. Even in the open treatment of non-union this faulty conception is evident. Methods are commonly practiced which have no other basis, and there are surgeons who apparently believe that two pieces of bone must unite if held together and that the method of approximation and means of maintaining it have no bearing on the success of the operation, other than through mechanical fixation.

In one case that came under my observation, the surgeon had begun by plating the fragments. When failure by this method was evident in due course, he used wire, after another disappointment, he resorted to nails. The third failure did not by any means shake his confidence in purely mechanical means, with a persistence worthy of a better cause, he put all three back—plates, wire, and nails (Fig. 10). Four times did he try to find a mechanical antidote for the particular case. He did not fail for lack of skill, applied to a piece of furniture, his repair would have outlasted the original. Approximation and fixation are essential, but these are only means to an end, the union of the fragments by the production of new tissue from one to the other.

I have tried to trace the reparative processes, following the introduction of the bone graft, from the formation of granulation tissue to the incorporation of the graft as an integral part of the host tissue. There are processes that go beyond the limits of anatomy and physiology. We know that all tissues react to changes in environment. A fractured bone manifests the greatest reparative power during the period immediately following the injury. Since injury thus stimulates repair, it is clear that the freshly removed graft has potentialities for repair that will become fully manifest as soon as it can establish its vascular connections. This reaction to environment takes



the form of increased metabolism. As the graft takes on its function of immobilization, its metabolism is further stimulated by the demands of its new environment. The adaptive response is increase in size and strength, and this is just what occurs. Later, the graft must adapt its structure to its new position and the stresses it encounters. Thus function determines structure, and modification of function brings about modification of structure.

*Other grafting methods.* The intramedullary graft has not justified the early hopes of those who advocated it. Henderson would appear to be unduly optimistic, however, when he states that it has been given up. Rather faint hearted recommendations of it are still occasionally seen. At its best, the method is applicable only to the largest bones, the femur, the tibia, and possibly the humerus. In all cases where eburnation and sclerosis extend back for a long distance, the limb must be materially shortened or the graft must be left lying loosely in a hole through bloodless bone. This operation was first advocated after experiments on a cadaver, the practical test of it has shown that the conditions in the living body are, or should be, entirely different. Granting that the marrow is the most important source of blood supply for the uniting structures, the process of reaming it out is manifestly very prejudicial to union and is contra indicated. The technique makes accurate coaptation of graft and host impossible so that vascularization of the graft is uncertain and defective, nor is there any strict immobilization, since all the graft does, or is expected to do, is to prevent gross lateral displacement. The most fundamental objection to the method is that dissimilar elements of bone are approximated, in violation of the biological principles of bony union.

Failure of union after the application of an intramedullary graft is an unusually vexing problem because of the destruction of the marrow and the consequent aggravation of the ischaemia of the fragments generally.

CASE 8. As the result of a motor accident a year and a half before I saw him this young man was suffering from non union of the right tibia. Casts had been repeatedly applied with no result (Fig

11 A). About a year after the accident an intra medullary graft had been used. Figure 11 B shows how disastrous the operation was to the medullary circulation and how ineffective it must have been, the graft was too short and too small to immobilize the fragments and too irregular to maintain effective connection with what little vascular supply the remaining of the marrow had left. Amputation had been eventually recommended.

I inserted an inlay graft from the sound tibia. The result 2 months later is shown in Figure 11 C. Callus was slow in forming at first and the cast was maintained for 10 months and then exchanged for a brace. Within a year the condition was excellent (Fig 11 D). It is now 2 years after the operation and there has been no trouble with the graft.

A study of the roentgenograms in this case will reveal more clearly than words can, the difficulties attending the insertion of an intramedullary graft and the objections to its use.

CASE 9. This patient was 30 years old. He had fallen about 28 feet, 6 months before, and fractured the right humerus in three places. After closed treatment for nearly 3 months, an intramedullary graft had been inserted in an attempt to promote union of the middle fracture. After 3 months in a cast, the patient came to me because of failure of union.

When I saw him there was most free motion at the site of fracture and considerable bowing of the humerus. The roentgenogram showed entire failure of union. From an inspection of the roentgenogram in Figure 12 A, one can learn not only how useless the graft was but also the uncertainty of immobilization by such methods. The figure shows how the marrow has been destroyed and reamed out to make room for the graft and how the latter is lying loosely in two hollow cylinders of calcium phosphate, without either mechanical or physiological justification for hope of its success.

I considered this a suitable case for the onlay graft since the marrow was gone and the endosteum probably damaged, if not destroyed. This apparently succeeded as is shown by the roentgenogram taken 2 months later (Fig 12 B). Five weeks later however, there was evidence of failure and the roentgenogram showed the graft cracked and apparently loose at the lower end.

There was now no recourse but the inlay graft. At this operation the old intramedullary graft was found free, having failed to unite with either humeral fragment. The inlay was apparently successful although callus developed slowly. Four months after operation the arm seemed solid, but, a few weeks later, there was motion at the site and a small crack was evident in the graft.

This case is still under consideration and is recorded because it illustrates not only the futility of the intramedullary graft, but the prejudicial effect this has on union by any other means. I have already referred to the necessity for utilizing every source of blood supply, and to the reason why it

striction of blood supply militates against the success of the inlay graft. It is probable that lack of blood supply so retarded the process of assimilation that the graft, instead of reacting properly to Wolff's law, gave way before the strain of function. It is only fair to say, however, that the graft was subjected to a more severe strain than it should have been in any case the patient admitted that he was shoveling coal when the fracture occurred.

In its early course, this case controverts the argument that non union has a constitutional cause. Of three fractures in the same bone, two united and one failed to unite. How much non-union may have been dependent on the technical difficulties of early immobilization and how much it was favored by the ill advised use of the intramedullary graft can only be estimated, but the fact that union failed in the middle fragment, which was cut off from direct vascular connections at both ends, illustrates how dependent union of bone is on abundance of blood supply and how the periosteal circulation, supplied by the muscles attached to the bone, may be unable to meet the demands of repair, especially if the soft tissues have been lacerated by a crushing injury, as in this case.

The osteoperiosteal graft, first advocated by Ollier, violates the principles governing the union of fractured bones. Since the periosteum normally supplies only one-third as much callus and blood as the endosteum and marrow, the nutrition of the graft is restricted, callus formation is limited correspondingly. In pseudarthrosis, the periosteum and usually the overlying soft parts as well share in the general ischaemia of the structures and may be practically bloodless. The inadvisability of applying a graft to a structure of such low vascularity should be evident, particularly when the inlay method provides contact with all the elements of the host bone and taps every available source of blood supply. The osteoperiosteal graft provides no mechanical continuity since it consists of soft tissue to which plaques of bone cling. It, therefore, cannot exert an immobilizing effect and, on that account, cannot be influenced by Wolff's law.

These objections apply to the onlay graft as well, except that anatomical continuity is preserved. The blood supply is maintained only through the cortex which is not well adapted to vascular anastomosis and does not normally provide any considerable portion of the circulation for callus formation, as has been explained. The method is biologically un-

sound because it provides for contact of only one of the elements of bone, namely the cortex. Further, the strength of the graft must be diminished by the necessity of drilling generous holes for its fixation by means of either autogenous pegs or screws or screws of metal or other material which has a destructive effect. The use of holed bone is especially to be condemned, its osteolytic effect has been demonstrated both experimentally and clinically. If the onlay graft is ever used, it should be fixed with pegs or screws of autogenous bone.

Fracture of an onlay graft is a catastrophe, because it then becomes no better than an osteoperiosteal graft without its periosteal vascular connections. When the onlay graft is used, there is always the difficulty of covering it with skin and subcutaneous tissue, especially when it is applied to the bones of the forearm or the tibia. It is often a case of choosing between covering it incompletely and using undue tension in approximating the soft tissues over it. Any procedure which increases the original diameter of the bone is, in this respect, hazardous.

Instead of the osteoperiosteal graft, I would use the sliver graft which has mechanical continuity, contains all four bone layers, and responds to Wolff's law. It can be taken from the side of the gutter where the large graft is obtained. Being thin, it can adapt itself to the contours and pressures of surrounding parts. It is a question whether, if the motor saw had existed in Ollier's day, he would not have used the sliver graft.

#### OTHER OPERATIVE METHODS

*Step-up operation (Senn)* The step up operation is faulty in conception and unfortunate in results. If union failed, either at the time of original fracture or at subsequent open operation, in spite of reasonably accurate approximation of the fragments, it is not likely that, in their sluggish state, the elements of pseudarthrosis will be able to unite. The argument cannot be used that the stimulating conditions of fresh fracture are reproduced by the operation, unless all of the sclerosed and ischaemic bone is removed. Hence the greater the shortening the better the chance of union.

the form of increased metabolism. As the graft takes on its function of immobilization, its metabolism is further stimulated by the demands of its new environment. The adaptive response is increase in size and strength, and this is just what occurs. Later, the graft must adapt its structure to its new position and the stresses it encounters. Thus function determines structure, and modification of function brings about modification of structure.

*Other grafting methods.* The intramedullary graft has not justified the early hopes of those who advocated it. Henderson would appear to be unduly optimistic, however, when he states that it has been given up. Rather faint hearted recommendations of it are still occasionally seen. At its best, the method is applicable only to the largest bones—the femur, the tibia, and possibly the humerus. In all cases where chondromatosis and sclerosis extend back for a long distance, the limb must be materially shortened or the graft must be left lying loosely in a hole through bloodless bone. This operation was first advocated after experiments on a cadaver, the practical test of it has shown that the conditions in the living body are, or should be, entirely different. Granting that the marrow is the most important source of blood supply for the uniting structures, the process of reaming it out is manifestly very prejudicial to union and is contra-indicated. The technique makes accurate coaptation of graft and host impossible so that vascularization of the graft is uncertain and defective, nor is there any strict immobilization, since all the graft does, or is expected to do, is to prevent gross lateral displacement. The most fundamental objection to the method is that dissimilar elements of bone are approximated, in violation of the biological principles of bony union.

Failure of union after the application of an intramedullary graft is an unusually vexing problem because of the destruction of the marrow and the consequent aggravation of the ischemia of the fragments generally.

**CASE 8.** As the result of a motor accident a year and a half before I saw him, this young man was suffering from non union of the right tibia. Casts had been repeatedly applied with no result (Fig.

11 A). About a year after the accident an intra medullary graft had been used. Figure 11 B shows how disastrous the operation was to the medullary circulation and how ineffective it must have been, the graft was too short and too small to immobilize the fragments and too irregular to maintain effective connection with what little vascular supply the reaming of the marrow had left. Amputation had been eventually recommended.

I inserted an inlay graft from the sound tibia. The result 2 months later is shown in Figure 11 C. Callus was slow in forming at first and the cast was maintained for 10 months and then exchanged for a brace. Within a year the condition was excellent (Fig. 11 D). It is now 2 years after the operation and there has been no trouble with the graft.

A study of the roentgenograms in this case will reveal, more clearly than words can, the difficulties attending the insertion of an intramedullary graft and the objections to its use.

**CASE 9.** This patient was 30 years old. He had fallen about 48 feet, 6 months before, and fractured the right humerus in three places. After closed treatment for nearly 3 months, an intramedullary graft had been inserted in an attempt to promote union of the middle fracture. After 3 months in a cast, the patient came to me because of failure of union.

When I saw him there was most free motion at the site of fracture and considerable bowing of the humerus. The roentgenogram showed entire failure of union. From an inspection of the roentgenogram in Figure 12 A, one can learn not only how useless the graft was but also the uncertainty of immobilization by such methods. The figure shows how the marrow has been destroyed and reamed out to make room for the graft and how the latter is lying loosely in two hollow cylinders of calcium phosphate, without either mechanical or physiological justification for hope of its success.

I considered this a suitable case for the inlay graft since the marrow was gone and the endosteum probably damaged, if not destroyed. This apparently succeeded as is shown by the roentgenogram taken 2 months later (Fig. 12 B). Five weeks later, however, there was evidence of failure and the roentgenogram showed the graft cracked and apparently loose at the lower end.

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Shortening is demanded not only by the necessity of getting back to normal bone but by the demands of the operation, since overlapping necessitates shortening. To be carried out with a reasonable chance of success, the operation requires at least 4 inches of shortening.

**CASE 10** This illustrates a case in which the Senn step operation for ununited fracture of the humerus failed. Figure 13 A shows the fragments fixed by a Parmelee band. The wire had been inserted at a subsequent operation. I removed the metal and inserted an inlay graft. The result is illustrated in Figure 13 B which shows proliferation of the graft. The ultimate result was excellent; it is now more than 2 years after the operation.

In this case the bone had been considerably shortened and length of the limb sacrificed all to no purpose. The roentgenogram shows not only the large amount of metal applied but its destructive effect on the bone.

**Mechanical fixation.** Suturing, wiring, nailing and plating following freshening of the ends of the fragments, are based on little but mechanical principles. If the osteogenetic power of the fragments, after the trauma of freshening, is at a high level, and if immobility is well maintained, union may occur. Such methods, therefore, leave much to chance, and the chance that osteogenesis will be vigorous and rapid in the bony members of a pseudarthrosis is not great. Suturing has the advantage that it is not so depressing to osteogenesis as the introduction of metal. Plating has the advantage of ensuring immobility, at least until the absorption of bone defeats its purpose. All foreign bodies have the disadvantage that they not only cause absorption of the bone with which they are in contact but that they favor low grade infection which inhibits union.

There is no doubt but that metal plates bring about union in favorable cases of fresh fracture but it must be clearly understood that they are never indicated in pseudarthrosis. Lane states that few surgeons appear to have sufficient mechanical knowledge or experience to deal effectively with fractures by operative procedures. He would thus appear to realize that his method is not successful in the hands of most surgeons. The failures are not always due to faulty mechanics, Lane

himself follows a most rigid aseptic technique, and Sherman makes the following emphatic comment: "The most scrupulous, aseptic technique is necessary if infection is to be avoided. Unfortunately, few surgeons have been sufficiently interested in this operation and technique to organize operative teams along the lines absolutely necessary if success is to be secured. One rarely finds this very rigid technique in practice except in a few clinics where open operation has been given special thought and attention. The surgeon who operates rarely in such cases finds it rather awkward and difficult to carry out such technique in detail, and as a result, he is prone to blame the plates, screws, catgut, or operating room nurse, when infection occurs. Sel-dom does he look to himself or consider himself a causative factor."

Even comparatively innocuous infection, combined with the osteolytic influence of the foreign body, may prove sufficiently virulent to check union. If the fragments do not unite speedily, while osteogenesis is at its highest level, or if infection of any grade sets in, the plates must be removed and some method used which is based on sounder principles. The failure of Lane's method in the treatment of pseudarthrosis is attributable to careless technique, inaccurate application of the plates and the use of too much metal, as well as to the inadequacy of the principles on which it is based. The method is justified in the treatment of fresh fracture only when the surgeon is highly skilled and controls a group of assistants and nurses whose training and facilities will ensure the most scrupulous asepsis and the most exact technique. It is under such conditions and by means of perfect apposition of the fragments, allowing end to end stress, that success has followed the use of these plates.

Sherman has carried out the principle of mechanical fixation in a great number of cases of fresh fracture with outstanding success, attributable not only to the exactness of his asepsis and perfection of his surgical environment, but to his care with the mechanical details of the operation. The most important of the latter is, I think, the self tapping screw. The original wooden screw was conical and

was held in place by its own compression on being driven into the bone. The pressure on the bone being "equal and opposite," the bone gave way and allowed the screw to loosen and even fall out. Sometimes the screw split the bone, as it always tended to. Sherman's screw does not taper and hence has no tendency to split the bone. It taps the hole drilled in preparation for it, that is, its sharpened thread makes a spiral groove in the side of the drill hole which the rest of the thread fills as the screw is driven home. The screw is thus not held by compression but by the engaging thread alone, and the bone is under no compression. If metal screws are ever used in the treatment of non-union, they should be of the self-tapping kind.

Plates of dead bone have no advantages over metal screws. They are made of lime salts instead of metal. Boiled bone is dead.

The use of silver wire persists because of two wrong impressions. Fixation with such unabsorbable material gives some surgeons more confidence in its permanency. As a matter of fact any such fixing agent has entirely served its purpose in a few weeks, and proper absorbable material will last that long. The surgeon who does not know and trust suture material has some justification for preferring a metal which he understands, or thinks he understands. Even he, however, should realize that foreign material in contact with bone is not desirable, after its work is done its presence is positively undesirable. I cited a case years ago that illustrates this point. Fracture had been treated by Lane's plates held in position by a silver wire encircling one fragment below the fracture. The work was well done and the fracture united perfectly. Six months later there was a spontaneous fracture of the same bone at the point of the encircling wire, the silver wire had caused the bone to melt away gradually.

CASE 11 This patient, a woman 30 years of age, had been seriously injured in a motor accident almost 3 years before I saw her. Meantime, various methods had been used in the attempt to unite the fracture of the right radius, casts, splints, and operative measures had been tried, including two attempts at bone grafting. Figures 14 A and B show the early and late results of one of these efforts. As shown in Figure 14 A, the attempt to insert a tibial

graft into the medullary canal had split the lower fragment, in addition to the obvious and inevitable destruction of the marrow before it was inserted. Figure 14 B shows absorption of the split off segment as well as of the graft itself. Union of the graft has progressed no further than might have been anticipated. The bone is badly out of alignment and the carpus distorted.

I saw the patient shortly after this roentgenogram was taken. Non union was evident. The hand was fixed in pronation and radial adduction and could not be rotated even passively.

I inserted a double wedge end inlay graft from the tibia. Figure 14 C shows the result 10 weeks later. Alignment was restored and the hand is now in proper position. This is a recent case, but massage promises to restore normal function now that union is solid.

As I have observed, the intramedullary graft, inadvisable in any case, is out of the question in non union of the smaller long bones. If proof of that were needed, this case supplies it. The marrow cavity is too small to hold a graft of sufficient size and strength.

CASE 12 Although I have reported this case before, I mention it again to show to what extremes the desire to saw off the bone and rely on metal fixation may be carried. It was a case of oblique fracture of the tibia. Instead of making use of this relationship of the fragments, the surgeon cut off a considerable amount of bone until both fracture faces were horizontal. Then he wired the fragments with silver wire. The wire broke and alignment at the end of 3 months was considerably worse than at the beginning. To non-union had now been added malalignment, marked shortening, and the presence of useless foreign bodies. Three operations of this nature had been performed with more and more shortening each time.

I used a sliding inlay graft with an excellent result.

A much more common proof of the disadvantages of permanency of fixation material is the incidence of infection. Low grade infection may be latent at the time of operation, or may be carried in from the skin, in either case the presence of the foreign body contributes materially to the chances of its development. Even when there is no local infection, the foreign body, by devitalizing the bone, makes it a possible nidus for any bacteriogenic infection, such are not as rare as was once thought. Many years ago, before the introduction of kangaroo tendon, I used silver wire to fix the fragments of a fresh fracture of the humerus. Everything went well for 10 years, when an abscess developed about the wire.

So much for the consideration of permanency. The other wrong impression is in regard to the strength of silver wire. Naturally one has in mind the difficulty of maintaining reduction in the face of muscle pull. I investigated the tensile strength of various sutures and wires some years ago, and the results may occasion some surprise even yet. Kangaroo tendon has a higher tensile strength than silver wire of comparable weight, and the knot stands more tension without slipping.

#### USE OF THE AUTOMATIC MOTOR DRIVEN SAWS

The motor with its sterilizable shell and attachments has been described in full elsewhere (1). In my first designs the motor was not powerful enough for all purposes, and the use of a flexible shaft was suggested, in order that a heavy fixed motor might be used. The motor of my design was improved and made adequate long since, but the flexible shaft is still used by some surgeons, inadvicably I believe. There is a limit to the power which a flexible shaft will carry, and either power or flexibility must be sacrificed. In fact, if the motor is powerful enough to drive the twin saws through the adult tibia, the shaft cannot be flexible. At the best, the tool, whether drill or single or twin saw, vibrates and "chatters," evidence of which is borne by the cut bone face. When the tool is carried by the fixed armature shaft, it cuts evenly and straight and the weight of the motor (4 pounds), to which theoretical objection might be taken, serves to steady the tool and absorb the vibration. As a result, the cut surface is smooth and even, the advantages, and even necessity, of which are evident from the discussion of coaptation and the physiology of bone union. The portability of the instrument, while not as important as it once was, is still a consideration in smaller hospitals.

The saws must be sharp and must be replaced, just like the blades of a safety razor, as soon as they become in the least dull. The worst fault is inequality of the cutting edges of the teeth. If a saw has touched an instrument, such as a retractor in the wound, it will immediately bear obliquely and no force will hold it straight. Even the twin saws will not run parallel but will bend under the unequal

resistance, the result is a graft of uneven thickness. Once a revolving saw has touched an instrument or has come under suspicion for any other reason, I never experiment with it.

The actual cutting of bone is mechanic's work. An accurate tool tends to hold to the line, one must not have the feeling of forcing it constantly to the line. One cannot saw a board that way, one cannot even draw a straight line in such piecemeal fashion. A surgeon with sufficient mechanical sense will trust his tools and work free hand, but if he will trust them he must respect them and know their ways. If the saw is pushed too fast it will not clear itself and will jump.

One sometimes sees a surgeon drawing the saw back and forth over the cortex, gradually working toward the marrow. That is a poor way to saw, not only because it is hard to hold the line in this way, but because the dense cortex will heat the saw. This is one of the results of timidity, swift cutting with sharp tools produces no destructive heat if carried out properly. The saw should be driven through to the marrow at the outset and the line followed through the entire thickness at once (Fig 5). This has the advantage of plunging the saw into the marrow fat, which serves as a natural lubricant so effective as to render the use of the saline drip (supplied by either an aural irrigating bulb or a gauze sponge) merely auxiliary.

I have seen many specimens of grafts when cases of failure of grafting have come to me. In one such, the crest of the tibia had been used and had been removed in a sliver of varying thinness by means of a single saw, either motor driven or hand driven. The wavering irregular saw line suggested that both motor power and hand power had been used, the latter too freely. The saw had been crowded, both forward and back and forth toward the line. I would not wish to represent bone sawing as a formidable mechanical procedure. Every surgeon should have enough mechanical gift to saw a board straight, and he should readily acquire knack with his hands in a new procedure.

#### PRE OPERATIVE MANAGEMENT

Reference has been made to the necessity for postponing operation if the bone has been

recently infected. If the history suggests the presence of latent infection, it is better to disclose it, by means of deep massage with manipulation of the fragments, than to have a recrudescence after the insertion of a graft. The infection is eradicated by surgical means and grafting not undertaken until the lapse of sufficient time after healing.

**CASE 13.** The non union in this case followed severe crushing of the right arm in a man aged 29 years. A fracture of the forearm had united after open treatment. The humerus was treated first by traction, then on two occasions by bone graft. The graft broke both times, the second time during manipulation. Infection had been present to a varying degree until 2 or 3 months before I saw him. Figure 15 A shows the result of one of the early attempts at bone grafting, and B the condition when I first saw the patient.

I first tried suturing with kangaroo tendon after resection of the scar tissue but, 2 months later, there being no union, I inserted a graft from the tibia. Infection recurred and the general condition was serious for some weeks. Transfusions of blood were given. The condition of the graft 10 weeks after operation is illustrated in Figure 15 C. The wound eventually healed, but 5 months after the operation again broke down and discharged and a sequestrum separated. The infection was controlled but the graft had been destroyed in the infected zone (Fig. 15 D). Five months later there was still no union and a second graft was inserted. Four months later union was firm (Fig. 15 E). Ten months after the operation the patient fell and injured the arm severely enough to cause a hæmatoma but the graft withstood the shock.

This case illustrates the necessity for caution in approaching bone in which infection has been recently active. More than 2 months had elapsed before the attempt at suturing the fragments. A bone graft was not inserted at the first operation, because the main purpose at that time was to resect the anæmic scar tissue in order to provide a healthier environment for the non union. The fragments were sutured in the hope that restoration of circulation might promote union. If it would not, I intended, according to my invariable practice, to wait for complete restoration of circulation before venturing to insert a graft.

The more extensive inlay operation, 5 months after the subsidence of the infection, brought about a recrudescence which not only destroyed part of the graft but seriously threatened the patient's life. I waited 9 months after the subsidence of this infection before attempting a second graft. This time there were no complications and an excellent result followed, which has persisted up to the date of writing, a year and a half after the operation.

When the infection destroyed the center portion of the bone graft, I inlaid a second graft in the frag-

ments of the first. The original graft was not dead. In a series of such cases, I have never found the original graft dead. As a matter of fact, it bleeds most profusely when cut with the saw. Thus does practical surgery confound the theorists.

If, in the survey of the case, the presence of extensive scar suggests that the graft cannot be surrounded by well vascularized tissues, the scar should be removed and replaced by an ample pedicle graft usually taken from the other limb. The bone inlay operation should not be undertaken until at least 1 month after the completion of the pedicled graft procedures.

The immediate pre-operative care is of the greatest importance. It is carried out for 24 or 48 hours. In my own practice the iodine preparation is always used.

#### TECHNIQUE

*The bone graft operation.* In all cases in which it is necessary to have the limb under mechanical control, the patient is placed upon the Albee fracture-orthopedic table for management, not only throughout the operation, but during the postoperative immobilization by plaster of Paris. The patient is, of course, anesthetized to the point of muscular relaxation, spinal anesthesia being used frequently for the lower extremities.

The fractured area is exposed by a generous skin incision. If scar is present but not too extensive, the incision should be made through healthy tissue when possible. The incision is made large enough to provide access to the pseudarthrosis without undue traction on the soft tissues. When the fractured bone is superficial, as in the case of the tibia, the incision is made lateral to the intended site of the bone insert. The skin and subcutaneous tissue are retracted and the bone ends are delivered and freshened with osteotome, motor burr, or saw. Anæmic scar tissue is carefully dissected away so that vascular tissue will come in contact with the graft. The periosteum is divided with a knife longitudinally over the bone to be removed in making the gutter for the bone insert. Periosteal flaps are turned back to either side and the bone exposed.

Two longitudinal parallel saw cuts, about  $\frac{3}{8}$  to  $\frac{1}{2}$  an inch apart, are made in the frag-



ment ends completely through the bone cortex to the marrow cavity with a motor twin circular saw. The distance between the saw cuts is arranged by adjusting the distance between the twin saws. These cuts are made from 2 to 3 inches into the end of each fragment from the line of fracture. While the fragments are held in good alignment, these cuts should always extend far enough from the line of fracture to reach well into the non sclerosed active bone of each fragment. This distance is subject to considerable variation, depending upon the site of fracture and the extent of eburnation present. The distance the twin saws should be apart, i. e., the width of the gutter for the graft, should vary according to the size of the marrow canal at the smallest diameter of the fractured bone involved in the cuts. With the small motor drill, holes are bored in the cortex on either side of the gutter to receive the smallest sized kangaroo tendon which will answer. These holes are placed near the line of fracture so as to fix the center of the insert.

The exact length of the desired inlay is obtained by measuring the gutter and transferring this measurement to the anterior surface of the tibia after its exposure. A flexible probe is usually satisfactory for this purpose, a right-angled bend marking the exact measurements. I have often used the carpenter's calipers. The wound and gutter are packed with hot saline compresses while the graft is being prepared. The graft yielding tibia is exposed by an incision over its crest. The overlying structures are retracted, and the size and shape of the graft are outlined in the periosteum by means of the scalpel with the probe measure and twin saw as a guide. With the twin saws adjusted to the same distance apart as when cutting out the gutter, plus the thickness of one saw blade, bone cuts are made to the marrow cavity along the anteromesial aspect of the tibia. The saline drip is used by either of the means mentioned. With a small motor driven saw, the graft is now cut at the ends and dislodged by the osteotome. The graft, thus made of sufficient length to extend to the end of the gutter, will have generous contact with the vascular marrow substance and normal bone cortex on either side of the

point of sclerosis and non union. In this way the marrow substance upon the graft has its best chance to be penetrated by host blood vessels and to act as a vessel conducting agent. An accurate fit is assured by the adjustment of the twin saws which are used both in the shaping of the gutter and in the formation of the graft.

Strands of kangaroo tendon passed through the drill holes previously made are raised on a long clamp from the bottom of the gutter, allowing the graft to be inserted beneath each of the four loops. By tapping the author's bone set (of which the carpenter's nail set is the prototype) against different regions of the graft, with gentle blows of the mallet, the graft is firmly seated in its gutter. The kangaroo tendon is then tied, care being taken that a secure knot is used, the last half of the knot is held by a ligature of chromic catgut. No. 1 tied at right angles to it to prevent any possibility of the knot untying under excessive stress. In this respect, however, the conditions are most favorable in that two strands of the kangaroo come over the graft at each of the four points. The site of the fracture is covered with the periosteal flaps which were reflected to expose the bone to be removed. This gives two layers of periosteum covering the transplanted fragment. The overlying tissues and skin are closed without drainage. It is most important that the tissues covering the graft be under no tension. No trouble results in this respect when the inlay is used, inasmuch as the diameter of the bone is not increased at the site of operation. All sutures should be absorbable and no larger than actually necessary.

The soft parts are approximated with continuous suture of No. 1 chromic catgut, the skin is closed with continuous suture of No. 0 plain catgut. The line of suture is puddled with 3.5 per cent tincture of iodine splashed into the line of suture by means of blows of a completely saturated sponge on the end of an instrument.

*Sliding graft.* In most cases the graft material is obtained from the tibia. If, however, the bone involved is a large one such as the femur, tibia or, possibly, humerus in the adult, and the conditions are favorable for the use of

the sliding graft, the twin saw enables a technique to be carried out whereby the graft is slid from one fragment to the other. This graft and the gutter in the receiving fragment may be formed completely by the twin saw, or the twin saw may be used merely as a marker and the single saw used with converging saw cuts, so that, in the latter instance, the graft has a semi-wedge cross-section and its depression below the surface of the recipient bone will ensure a tighter fit. Otherwise the technique is identical with that of ordinary inlay.

**Double-wedge-end graft (Fig 21)** Whenever the bone fragments are small and conical in section, such as in the forearm in the adult, or when the bones are small or conical-ended in children, I have advised and employed for many years the double-wedge-end graft. In this instance the twin saw is not used at all. The wedge-shaped gutter is shaped by a single saw in a very similar manner to the gutter made by the twin saw. In this instance, however, the surgeon will have to use his judgment in determining just how large a wedge should be removed from either fragment. If the bones are especially small, the wedge-shaped cavity is enlarged by splitting the bone fragments longitudinally by means of a thin osteotome thrust into the apex of the wedge-shaped gutter distally to the point of non-union. This causes the wedge-shaped gutter to spread so that it will receive a stronger graft of larger diameter at its center which determines its immobilizing strength. The drill holes are made precisely as in the ordinary inlay operation. A pattern of the graft is then mapped out upon the anteromedial surface of the tibia to measurements taken of the enlarged wedge shaped gutters just made in the fragments. With a single saw a graft of the complete thickness of the cortex is removed. The technique of insertion is precisely the same as in the ordinary inlay, but the procedure is simplified by the use of tin clips. The size and strength of the graft must be ample. The sole object of the wedge shaped contour is to provide a means of inserting a larger and stronger graft.

**CASE 14** This patient had been in a serious accident 2 years before I saw him. He was sent by the

Pennsylvania Railroad. The right radius and ulna had been fractured (Fig 16 A). Numerous attempts to promote union had been made: (1) September 16, 1923, splinting under anæsthetic, (2) October 22, 1923, open operation to freshen the ends of the fragments, (3) January 29, 1924, application of metal plates, (4) April 25, 1924, removal of plates and in section of bone grafts, (5) February 24, 1925, kangaroo suture of fragments, (6) March 9, 1925, fragments wired, after marked resection of bone ends, according to Senn's recommendation.

Figure 16 B shows the failure of the grafts inserted in April, 1924, this X ray film was taken 3 months after, C illustrates the result after another interval of 3 months, and D the result 5 months later, E was taken 10 days after the suturing operation in February, 1925.

The patient came to me 5 months after the last operation. I inserted a double wedge end inlay graft in the fragments of each bone after removing the wire. Union was slow but eventually became solid. Massage was used to stimulate union and restore joint function. Three months after the operation, union was solid and movements of the elbow and wrist fairly satisfactory. The result 6 months after the operation is shown in Figure 16 F. It is now  $4\frac{1}{2}$  years after the operation and he is actively employed by the railroad.

Two years after the operation, the case was presented and the result demonstrated before the Association of Surgeons of the Pennsylvania Railroad. I attributed the failure of the earlier operations to the faulty methods used. Bone had not only been destroyed by the injudicious use of metal but had been cut away *en masse* during the Senn operation. Such methods cannot be described as anything but meddlesome surgery. In general, the early treatment indicates a mechanical, and therefore a short sighted and one sided, view of the nature and treatment of non union.

**CASE 15** This patient was 56 years old when first observed, 3 months after she had slipped and fractured the left radius and ulna. A cast had been worn for 6 weeks, and then traction had been tried. Then, at an open operation, the fragments had been sutured with kangaroo tendon. Non union had developed when I first saw the patient (Fig 17 A).

I inserted a double wedge end inlay graft in the fragments of each bone because the fragments were not large enough in diameter to receive grafts of sufficient strength if shaped and inserted according to the ordinary inlay technique. Supplementary sliver grafts were also used. The roentgenogram taken almost 3 months later (Fig 17 B) showed excellent union. Function was completely restored and has remained unimpaired to date, nearly a year after the operation.

In this case, a window had been left on each side of the cast for the application of diathermy. The loss of immobilization had more importance than the uncertain effect of diathermy. The surgeon, I fear, sacrificed the substance for the shadow—

almost literally. Windows are made in casts for various reasons, none of which is sufficient to justify the sacrifice of immobilization. I have by chance had the opportunity of judging the efficacy of diathermy in a large number of cases in which it had been used by others. In many cases it had been given for long periods in one for a whole year. There was no evidence, either clinical or by roentgenogram, that it had caused any stimulation of osteogenesis.

CASE 16. The patient, 63 years old, had fractured the right radius and ulna 2 months before. Open operation had been performed a few days later. The non union, when I saw her, is illustrated in Figure 18 A.

I inserted a double wedge end inlay graft from the tibia into the fragments of each bone (indicated by arrows in Figure 18 B). Two months later the condition was satisfactory and the cast was left off. Three weeks later the patient was dismissed, the result being considered excellent. It is now almost 4 years after operation and the arm has functioned well (Fig. 18 C).

The promptness of union and the excellence of the result would surprise those who adhere to the belief that advancing years present a serious obstacle to the union of bones and grafts.

In all cases the limb should be splinted in plaster of Paris applied so as to immobilize the joint above and the joint below. Too much emphasis cannot be laid on the importance of the careful application and molding of the plaster. It should be done either by the surgeon himself or by a well trained assistant on whose skill the surgeon can rely. Proper immobilization after the operation is even more important than after the reduction of a fresh fracture. In both cases laxity permits hinge movements at the site of fracture but after the application of a bone graft it allows either rocking of the graft in its gutter or its displacement from the gutter and results in fracture of the callus and disruption of the vascular bridges between graft and host.

A suitable orthopedic table such as that designed by myself (Fig. 19), greatly facilitates the application of plaster or other dressing. Figure 20 shows a shoulder spica extending to the wrist. This was applied while the patient was in the position illustrated in Figure 19.

#### POSTOPERATIVE TREATMENT

The cast should not be disturbed for 3 weeks. If non absorbable sutures have been erroneously used, no harm is done by their actual removal or by cutting a window in the

cast, the harm is done by removing the splint padding and dressing from over the line of suture. This disturbs the equality of splint pressure and ruins the immobilizing influence of the cast. A window is liable to cause oedema which produces increasing pressure and stagnation and may seriously disturb the nutrition of the healing bone (Fig. 22).

When the cast is bivalved and removed, the limb is carefully and gently tested for consolidation. The region of fracture is then roentgenographed. If union is not complete, immobilization is continued with the bivalved cast. This is removed daily for massage not only of the area of operation but widely over the limb, the object being to stimulate the circulation and callus formation. If consolidation is not complete in a reasonable time, a brace may be so applied as to allow function without too much lateral stress on the point of non union. A surgeon is more efficient if he is able to design braces, he should at least be able to advise the maker and consult intelligently with him.

In many cases in which osteogenesis is slow, the critical period is during the stage of restoration of normal bony structure in the callus. As has been pointed out, the callus does not attain its full powers of resistance until the trabeculae have been rearranged in conformity with those of the host bone. In slow cases, this process may be delayed long after the callus has become hard and the limb apparently firm. It is during this period that physiotherapy is being used to stimulate enlargement of the graft and to restore full movement to joints after their restriction in casts, or the patient may be allowed to bear weight or carry his arm without support. It is obvious how carefully physiotherapy should be supervised and how gradually the patient should be allowed to bear weight, since weight bearing is one of the stresses which influence the trabecular reconstruction of the callus and the graft. Manual examination for consolidation should not be repeated too often. If the surgeon will keep in mind the various stages of repair, and not think of callus as a kind of glue that has set, he will be able to visualize the process of union and suit his postoperative cases to actualities. It is not always easy to steer a safe course since (1) full function

should not be allowed until union is complete and (2) the processes of union are not complete until the new bone has been molded by the stress of normal function

In all cases the after-treatment must include much physiotherapy, the interval since the original fracture has been so long that joint stiffness and tendon adhesions are only overcome with difficulty. Baking and diathermy are followed by manual massage which is the most difficult, the most important, and the most exacting. The services of an expert (preferably a woman) are necessary. In 25 years I have become more and more convinced that only a woman can control a patient satisfactorily and so direct his mental reaction that he will not fear manipulations, but will surrender the limb without that sense of distrust which will engender muscle spasm and entirely defeat the objects of manipulation. Physiotherapy demands unusual qualities of mind as well as manual skill. There can be no formula since progression depends on the development of union, which only an experienced surgeon can gauge. The nature and extent of physiotherapeutic treatment must be determined, therefore, by the surgeon who maintains intimate acquaintance with the case and close co operation with the masseuse. In most cases in which the graft fractures or breaks away from its attachment to the host bones, the fault lies in careless supervision of convalescent treatment or adherence to a routine in physiotherapy.

#### REVIEW OF CASES

To illustrate the general nature of the cases one may expect to treat the complications one encounters, and the advantages of the inlay bone graft method. I am presenting 754 cases of non union. The site of fracture, the method of treatment, the complications, and the results are presented in the Table.

The humerus was involved in 201 cases, the radius or ulna (usually both) in 162, the femur in 121, and the bones of the lower leg in 270.

The nature and difficulty of the cases is revealed by the number of operations performed before the cases came under my observation. Operations from one to five in each, had been performed in 317 cases. A few of these were

#### TREATMENT AND RESULT IN SEVEN HUNDRED FIFTY-FOUR UNUNITED FRACTURES WITH OR WITHOUT LOSS OF BONE DURING THE PAST TWENTY-ONE YEARS

Site of fracture	Cases
Upper arm	201
Forearm	162
Thigh	121
Lower leg	270
Loss of substance	
None	676
Present	78
Previous operation	317
Type of operation	
Inlay graft	541
Sliding graft	198
Inlay with osteotomy	4
Fibular graft	3
Wedge mortise	1
Preliminary skin pedicled graft	19
Plastic on graft	6
Postoperative complications	
Infection	18
Wrist drop	4
Fracture of graft	9
Re union of graft without operation	4
Results	
Good	(89 per cent) 671
Poor	(11 per cent) 83

No case has been included in the series in which there was not a complete non union or pseudarthrosis and also no case has been classified as a success in which union has been present less than 6 months.

for sequestrectomy following infection, but in the main they consisted of the insertion of wire, bands, plates, or bone grafts of various types. As a rule they went in pairs application of the metal and, later, removal of it. In some cases these foreign bodies were revealed when I operated, sometimes clinging to dead bone, sometimes in a well of pus, but always a tribute to the persistence, if not the good judgment, of the operating surgeons.

Ununited fracture of the humerus naturally brings up the question of the musculospiral nerve, especially in a series such as this in which previous operations had commonly been performed. If musculospiral paralysis was present before operation, I classed the result as good if otherwise, satisfactory, in some of these, however, successful treatment was carried out by a neurological surgeon. Wrist-drop occurred after the inlay operation on the humerus in 4 cases.

The graft broke or gave way in 9 cases, in 7 of which it reunited and a good result was obtained. In one case, in which a long graft

had been inserted into a tibia largely destroyed by osteomyelitis, the graft bowed and plastic operations were necessary to straighten it.

The ultimate result was good in 671 cases (89 per cent) and poor in 83 (11 per cent). In all of these cases the percentage of cure by all methods had been zero, and the percentage of cure in 317 of them, by operative measures, had likewise been zero. It seems superfluous to point out the advantages of the inlay bone graft method.

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PRIMARY AND SECONDARY OVARIAN CANCER<sup>1</sup>

## A HISTOGENETIC, MORPHOLOGICAL, AND CLINICAL STUDY

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THE problems of histogenesis and classification of primary ovarian cancers and the differentiation of the primary from the secondary types, have occupied the attention of the foremost histopathologists since the dawn of cellular pathology, and yet we find our knowledge in these fields encumbered today with as many diverse interpretations and extraordinary conjectures as then.

The dominant histogenetic theory about ovarian neoplasms, which tradition has sanctified into an axiomatic truth, is the "embryonal rest" theory of Cohnheim. A painstaking study of the best contributions to this subject reveals that the adoption of this theory rests mainly upon suppositions and inferences, instead of direct histopathological facts showing a structural continuity between these rests and the neoplasm to which they are supposed to have given rise.

The want of histogenetic clarity has also dimmed the subject of tumor classification, which is still further confused by the persistent failure to view tumors as syntheses of growth phases, which must be described as morphological variations of one and the same tumor instead of distinct tumor entities.

In undertaking the present study, I have entertained many doubts as to the value of the results that my search may yield, and have therefore approached it with "a feeling of contemning no man's opinion, and with a desire to light my own torch at every man's candle." My claims are (1) that primary ovarian cancer arises from epithelial elements which constitute part of the fully formed sex gland and not from hypothetical "embryonal rests", (2) that tumors in the course of their evolution present different phases of growth which are not entitled to separate classifications, (3) that there is a close relationship between growth and function, and (4) that "tumors may and do assume the function of the organ from which they sprung."

The present study embraces the consideration of granulosa cell cancer, papillary adenocarcinoma, and secondary or metastatic cancer of the ovary.

## GRANULOSA CELL CANCER OF THE OVARY

In 1855 Rokitsansky described for the first time a type of ovarian cancer composed of epithelium closely resembling the granulosa of the follicles and in which folliculoid and ovuloid bodies are present from time to time. Thirty-three years later Acconci published a similar observation. Since 1888 many theories and hypotheses have been evolved about the origin and morphology of this rather rare type of ovarian cancer. The pertinent questions in the study of granulosa cell cancer are: The genetic source, the morphologic significance of the ovuloid and folliculoid bodies, and the interpretation of the different configurations assumed by the granulosa cells.

## THE GENETIC SOURCE OF THE GRANULOSA CELLS

The two main theories accepted by most investigators are the "granulosa strands" of Walthardt and the "granulosa balls" of Robert Meyer. Both these theories are based upon embryological suppositions purporting that parts of the germinal epithelium that dipped into the ovarian substance during the formative period for the formation of follicles, have never reached this structural goal but have remained as embryonal inclusions. Through some biological impulse these structural vestiges of the rete ovarii and the medullary rays have assumed growth properties and produced the granulosa cell tumors.

How far are these embryological theories substantiated by histopathological findings? Most authorities deny the existence or persistence of these embryonic rests in the fully formed and functioning human ovary. Robert Meyer reported one instance only in which he

<sup>1</sup> Read before the Gynecological and Obstetrical Society of Baltimore, February 14, 1930.



Fig 1 No 4804 Granulosa cell cancer of the ovary. A phase in the evolution of the tumor in which the generative and intergenerative elements retain an almost normal proportion. In some of the follicle *F* the ova and the germinal pots are distinctly seen. In some follicles the contents have undergone liquefaction. We also note the earliest beginnings of granulosa cell proliferations *GC*  $\times 40$



Fig 2 No 4804 Granulosa cell cancer of the ovary. A follicle cyst, *FC* showing a proliferation of granulosa epithelium *GE* extending into the stroma and into the corpus luteum *CL*  $\times 55$

has found these embryonic remains. In a splendid contribution to the subject of ovarian tumors in 1920, Goodall stated that he had found medullary rays and rete ovarii quite frequently in human ovaries during the fetal and the prepubescent periods only. Goodall's findings agree with those of the majority of investigators. The finding of granulosa cell tumors in women nearing or past the menopause lends additional verification to the claim that the embryological rests could not possibly be the genetic source of these growths.

Can the epithelium of the follicles be the histogenetic source of granulosa cell cancer? Robert Meyer stated in unmistakable terms that no blastomata can arise from follicles, or from any part of them. This postulate can not be accepted in its totality. We must differentiate between the proliferation of follicles as such and their epithelium. It is an established biological truth that in the human species there is no postnatal proliferation of follicles. The 200,000 follicles with which the human ovary is endowed at birth never increase in number thereafter. In the process of ovulation they undergo elimination, and at the end of the procreative period only traces of their existence are found in the form

of scar tissue replacement, called corpora fibrosa and albicantia. The epithelium of the follicles, however, with its unequalled metaplastic prodigiousness, can undergo structural and numerical variations of the widest range postnatally, and give rise to benign and malignant tumors. I claim, therefore, that the granulosa of the follicles can be and is the genetic source of granulosa cell cancer, as will be shown by my histopathological findings further on.

#### THE MORPHOLOGICAL SIGNIFICANCE OF FOLLICULOID AND OVULOID BODIES IN GRANULOSA CELL CANCER

Von Kahliden, in 1895 considered these morphological phenomena as "a segmentation process of primordial ova in the adult female." Stoeckel, in 1899, considered this type of ovarian cancer "as a formation of ova and primary follicles in senile ovaries." Amann, in the same year, recorded the folliculoid type of cancer as "a new type of malignant microcytic degeneration of the ovary." Gottschalk, in 1899 and in 1902, coined a new nomenclature for this variety of carcinoma, namely "malignant folliculoma ovarii."

In 1902, Pick stated that the folliculoid tumors described by Gottschalk and by Krompecher were in reality forms of "ovarian struma." Liepmann wrote in 1904 "The



Fig 3 No 4804 Granulosa cell cancer of the ovary A phase in which the granulosa cells are arranged into irregular wavy strands of various thicknesses or into alveolar and medullary shapes, the rotundity of the epithelial cells is not so pronounced, elongated and polygonal forms are encountered  $\times 58$

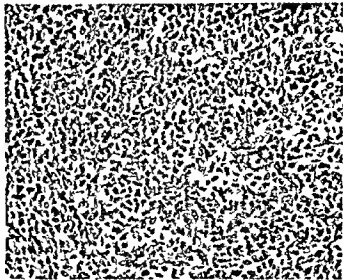


Fig 4 No 4804 Granulosa cell cancer of the ovary A phase in the evolution of the granulosa cell tumor, in which the proliferating granulosa cells form the dominant structural constituent, the stroma is reduced to the lowest proportions, and no traces of the follicles are present  $\times 58$

ovular formation in ovarian cancer is the result of a regressive metamorphosis, and the designation 'ovular' is baseless, and must be considered as a biologic prodigiousness "

In 1907 and in 1925, Blau stated that his histological investigations led him to believe that "through the proliferation of cells having the morphological potentialities of granulosa epithelium, follicle-like structures are formed with a theca interna. In some follicles there is also an apparent proliferation of lutein cells. These changes resemble the regressive stages of the corpus luteum. In other parts, the proliferation of the cells is more diffuse, and they form nests without the formation of follicles. Blau's description coincides with my own reported in 1923, and his biological concept of the pathology of this tumor is not quite correct as I will show subsequently.

Pfannenstiel's opinion expressed in 1908 varies greatly from that of Blau. He stated "It is very daring to draw the conclusions from the folliculoid appearances of these structures that we are dealing with follicles. The tumors that have been described as folliculoma have thus far been proved to be partly metastatic carcinoma, partly ovarian struma, or primary ovarian cancer with follicle-like bodies, which has led some authori-

ties to believe that they are dealing with follicular proliferations "

Robert Meyer's hypothesis proffered in 1918 is quite unique, it postulates "the cells which form the granulosa cell tumors, being derivatives of the germinal epithelium, have a tendency to group themselves around secreted drops extruded by the degenerating cells in a concentric fashion and thus to form round or oval bodies or spherical structures, simulating follicles." He termed this process "liquefaction "

Von Kahliden, Polano, Voigt, v. Werdt, and Krompecher also accepted the theory of degeneration as the causative factor of folliculoid and ovuloid formations in granulosa cell cancer.

Goodall, in 1920, stated that "the granulosa epithelium has the potentiality of forming structures simulating follicles and of producing all the characteristics of true follicles even to the extent of imitating oogenesis "

Sternberg, in his latest contribution to the subject of ovarian tumors, in Halban and Sert's *Biologie und Pathologie des Weibes*, sets to naught all the theories about the potentialities of the granulosa cells in forming follicles and states "The resemblance of the follicles and the ovules in granulosa cell cancer to true



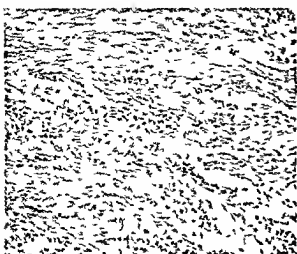


Fig 5 No 6358 Granulosa cell cancer of the ovary. Cortical part of the tumor showing an abundance of stroma, no follicles, the epithelial cells scattered in single rows or oval and round aggregates. The cells have a round spindle or polygonal shape. No signs of necrosis, hyalinization or lymphocytic infiltration.  $\times 50$

follicles is so slight and insignificant that the designation of these structures with the terms folliculoma is absolutely unjustifiable."

Neither the theory of postnatal proliferation of follicles nor the denial of even a structural resemblance of the folliculoid bodies in granulosa cell cancer to follicles, solve the genetic and morphologic problems of granulosa cell cancer. The proliferation of follicles after birth does not occur in the human female, although it has been observed in the bitch, but that the granulosa cells possess the metaplastic potentialities of the germinal epithelium must be accepted as a scientific working hypothesis, without introducing the far fetched theory of "hyaline degeneration" of Blau, or the "liquefaction" postulate of Robert Meyer. It is my firm conviction that we are much nearer the biological truth if we substitute for the theories of "degeneration" and of "liquefaction" the concept of "reversion to type" as the cause for the formation of the folliculoid and ovuloid bodies in granulosa cell cancer. My own investigations have brought me still closer to the histogenetic and morphological truths of this problem, and I shall show later on that the granulosa proliferation starts from the ovarian follicles, and that the folliculoid and ovuloid bodies in

granulosa cell cancer are follicles or the remains of follicles, and not the result of liquefaction or degeneration.

ARE THE DIFFERENT CONFIGURATIONS ASSUMED BY THE GRANULOSA EPITHELIUM DIFFERENT TUMOR ENTITIES OR DIFFERENT PHASES OF ONE AND SAME TUMOR?

An enumeration of the multiplicity of headings under which granulosa cell cancer has been described will indicate our morphological uncertainty. In 1904, we find three reports on this type of ovarian cancer under three different names: folliculoid cancer of the ovary, by Voigt, pseudo endothelioma of the ovary, by Polano, ovular formations in ovarian cancer, by Liepmann. In 1907 Brenner described a follicular oophoroma, and Inguir, a folliculoma ovarii. Werdt, in 1916, described this form of ovarian cancer, as a granulosa cell tumor, thus readopting Rokitsansky's original description. Tavildaroff, in 1919, coined a still other term, immature follicular oophoromata, and in 1923 described the same tumor as a "peculiar type of malignant neoplasm of the ovary."

Ulesco Stroganowa in 1924, wrote on "Folliculoma Ovarii Carcinomatoides." Krompecher in 1925, described three different morphological entities, "folliculoma," "oophoroma," and "granulosa cell tumors" as component parts of one and the same tumor.

Notwithstanding the correct morphological interpretation of Krompecher, Blau in 1926 reverted once more to the older teachings and considered the "cylindroid" and the "alveolar" types of ovarian cancer described by Robert Meyer as subgroups of folliculoma ovarii, but refused to classify them with the oophoromata of Brenner or with the folliculomata of Kahlden, claiming the latter varieties to be benign neoplasms. Neumann in 1927 accepted the views of Blau.

My own contribution to the subject of folliculoid cancer, in 1923, did not add a single ray of light to this complicated and confused histogenetic and morphological problem, because my histopathological finding at that time did not differ from those already recorded, and my morphological interpretation was pursued along the accepted methods and



Fig 6 No 6388 Granulosa cell cancer of the ovary. A phase of growth in the evolution of the tumor in which the granulosa epithelium is arranged into strands, alveolar and cylindrical masses, forming a pattern closely resembling mohair silk. The cells are characterized by their large, deep staining nuclei, which fill the cell bodies  $\times 50$



Fig 7 No 6388 Granulosa cell cancer of the ovary. A phase in the evolution of the tumor when the granulosa cells form the main constituent of the neoplasm, about the center there is a round space, and ovula formation, or rather the remains of a follicle, surrounded by columnar cells. In the lower right corner there is another follicular space filled with round epithelial cells  $\times 40$

concepts. Since then I have had the opportunity of studying 4 more cases, which in my opinion have supplied the essential facts necessary to take this controversy out of the realm of hypotheses and conjectures and to place it upon a sound scientific basis.

In the light of biological progress, we must relinquish the older methods of tumor classification, which had its foundation rooted in the local and limited description of what was seen at the time the tumor was examined. This procedure has led to a confusing nomenclature. A tumor must be considered as a composite of growth phases, which are forever changing as long as the neoplasm remains part of the economy. It is true that if a tumor is subjected to an extensive microscopic study several phases may be encountered in one and the same growth, furthermore, the phases noted during the earlier periods of the tumor's evolution may be different in appearance from those which would be found if the tumor were removed at a later date. Conceiving the process of tumor metaplasia in this light, we may hope to reach a clearer conception about the origin and classification of tumors in general and to state definitely that the different configurations noted in granulosa cell cancer are not separate and distinct

tumor entities as claimed by many observers but different morphological phases of growth of one and the same tumor type.

#### HISTOPATHOLOGICAL AND CLINICAL FACTS IN GRANULOSA CELL CANCER

CASE 1 Path No 4804 R L, aged 30 years, came under my observation on May 6, 1928, complaining of continuous uterine bleeding since January, 1928, following the termination of her first pregnancy in the seventh month of gestation. Menses began at 15 years, were irregular in type, and occurred every 4, 8, to 12 weeks. Since her marriage 3 years ago the menses have become normal, of 8 days' duration and abundant. Toward the end of the third month of her pregnancy the voice became deep and coarse and has remained so up to the present time. During the fifth month of gestation her face, abdomen, and the lower extremities became covered with a luxuriant growth of hair, which is still present. Throughout the entire pregnancy she vomited daily, and has lost 11 pounds in weight.

Patient is a short, well built individual, who except for her basso like voice, and the facial and somatic hirsuties, presents all the primary and secondary characteristics of a normal female. The vaginal outlet is normal. There is a moderate bloody uterine discharge. The cervix points backward, the uterus in anterior position is slightly enlarged but otherwise normal. The left adnexa are negative to palpation. The right ovary is of the size and outline of a hen's egg, freely movable and of a semisolid consistency. No other tumors or nodules are felt.



Fig. 8 No. 9035 Granulosa cell cancer of the left ovary. The uterus *U* shows a moderate thickening of the wall; a submucous polyp *P* extends from the fundus to the level of the internal os. The right tube and ovary are normal. The left ovary, *LO* is the seat of a solid globular tumor; the corresponding fallopian tube lies over its upper pole.

On May 7, 1928, I performed a curettage, right salpingo-oophorectomy, and appendectomy. The recovery was uneventful, and the uterine bleeding ceased on the day following the operation.

Pathological examination showed the following: The right ovary is grayish in color, slightly irregular in outline, of a soft doughy consistency, with a smooth intact serous covering and measures 7 by 4 by 5 centimeters. On cross section the tumor presents two distinct structures: a capsule whitish gray in color, very thin except at the lower and inner borders where it attains the thickness of 1 to 1.5 centimeters and can be recognized as ovarian tissue. The neoplastic portion is steel gray in color, of a uniform semisolid consistency and contains an oval golden yellow body the size of an olive in its outer and upper pole. Sections from the thicker part of the capsule (Fig. 1) show a typical ovarian stroma harboring many follicles in some of which ova are distinctly seen. In others the intrafollicular contents are liquefied and stain pinkish red. In the upper right corner of this section, as well as in the stroma lower down, we see collections of epithelial cells with dark staining round and slightly oval nuclei which occupy the entire cell body and resemble the granulosa cells. About the center of this section these cells seem to spring from the wall of a secondary follicle. In another section we note a follicle cyst (Fig. 2) from the outer wall of which there extends a marked proliferation of granulosa epithelium, which encroaches upon the stroma, displacing but not destroying it and invades a neighboring corpus luteum. The tumor proper (Fig. 3) contains no vestige of the normal generative elements; the granulosa cells, some of which are round, others ovoid, and still others polygonal, are arranged in irregular winding bizzare strands or whorls with varying amounts of ovarian stroma interspersed. In other parts (Fig. 4) the tumor presents structural

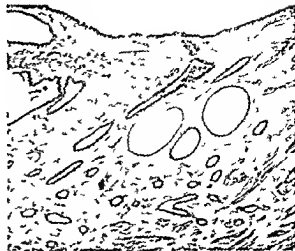


Fig. 9 No. 9035 Uterine mucosa in a case of granulosa cell cancer. The endometrium shows a marked hyperplasia and side by side cystically dilated glands, bearing a low cuboidal epithelium; there are others lined with a high columnar epithelium which is actively secreting.  $\times 30$ .

phases in which the granulosa epithelium dominates the field. The golden yellow body noted grossly proved to be the corpus luteum of the recent pregnancy. In none of the sections did I find evidences of marked cellular irregularity, mitosis, lymphocytic infiltration or necrosis.

Had I been content with the examination of the tumor sections presented in Figures 3 and 4 only, I would have had to make a diagnosis of either solid, cylindroid, or of granulosa cell cancer, thus offering a multiplicity of names, without gaining the slightest information as to the possible histogenetic source. Figures 1 and 2, however, representing parts of the tumor in which ovarian tissue could be recognized grossly, have furnished the sought for evidence. It needs no great stretch of our imagination to visualize how the granulosa epithelium which began to proliferate from the walls of the follicles has, in the course of the evolution of the tumor, formed first into thin strands or clumps, then into thicker and wider strands, which have fused with one another and have ultimately almost completely displaced the stroma and the generative elements themselves and have formed a solid tumor composed exclusively of granulosa epithelium. Following this process of reasoning, based upon histopathological facts, we see how erroneous our former methods of tumor



Fig 10 No 9035 Uterine polyp in a case of granulosa cell cancer. Note the marked glandular hyperplasia, and the actively secreting epithelium lining the gland lumina  $\times 35$



Fig 11 No 9035 Granulosa cell cancer of the ovary (Follicular phase). The granulosa cell character of the proliferating epithelium is distinct, follicle spaces of round and oval outlines, without normal intrafollicular contents are present, the proliferation of the granulosa epithelium proceeds from the follicle spaces into the stroma, the fusion of the epithelial proliferations results in the formation of solid granulosa cell tumors  $\times 45$

classification was. These different cell groupings in granulosa cell cancer are not different tumors, but different phases of growth of the very same tumor. The clinical facts in this case also shed light upon the problem of the relationship between growth and function. The persistence of the corpus luteum of pregnancy should have inhibited uterine bleeding. It failed in this instance, because the proliferating granulosa epithelium retained not only the structural potentialities of the parent tissue but also its functional proclivities, which overpowered the inhibitory forces and stimulated the endometrium, hence the persistent bleeding as long as the granulosa cell tumor formed part of the economy.

CASE 2 Path Nos 6388 and 9839 P S, aged 36 years, came under my care on October 14, 1915, complaining of a progressive enlargement of the abdomen which has become very pronounced within the past 3 weeks. Menses began at 17 years, were four weekly in type, painless, and moderate in amount. For the past 4 years hypomenorrhea has been noted, the intervals varying from 6 to 8, and 11 weeks. The last period occurred 1 week ago. She has been married 15 years, has given birth to three full term normal children, the last one 10 years ago. Her relative sterility is not volitional. Physical examination discloses a large, tense abdomen containing a huge cystic tumor. The uterus is of a normal size and outline, and lies in front of the lower pole of a huge ovarian cyst.

October 18, 1915, I performed a right salpingo-oophorectomy, preceded by the aspiration of 7,200 cubic centimeters of a serosanguineous fluid from the ovarian cyst. Some of the cyst contents escaped into the peritoneal cavity. The uterus and the left adnexa looked normal. The recovery was smooth and the patient left the hospital on the twelfth day, feeling well.

Pathological examination reveals the following: A huge ovarian cyst, with a smooth glistening surface, the walls of which are alternately thick and thin. The contents are serosanguineous, and the inner surface has a soft velvety irregular appearance. The serosa is covered with a low cuboidal epithelium which is wanting in some parts. Right under the serosa is a layer of ovarian stroma of varying thickness (Fig 5) infiltrated with round and oval epithelial cells with large, dark staining nuclei, filling the cell bodies. In the more mesial sections of the tumor we find the parenchyma cells arranged in two forms: a mohair silk pattern (Fig 6) and a solid mass of epithelium (Fig 7), which shows in various parts round or ovoid spaces with a homogeneous pink liquefied mass in the interior. While the cells maintain throughout a fairly uniform rotundity, those bordering on the ovoid spaces assume a columnar shape. Mitosis, lymphocytic infiltration, and necrosis are wanting.

On February 11, 1917, the patient reported that since her operation 2 years ago, the menses have been normal and that the last period occurred on June 9, 1916. An examination disclosed a gestation of 8 months. On March 17, 1917, I delivered her of

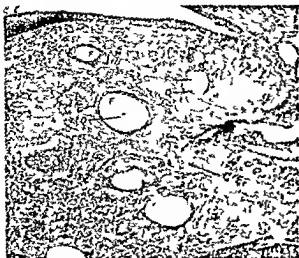


Fig. 12 No 9099 Granulosa cell cancer of the ovary. In an early phase in the development and growth of a granulosa cell tumor the follicles *F* are easily identified. Some of them still contain ovules *O* and germinal spots. Note the invasion of the stroma by the proliferating granulosa epithelium *GE* which proceeds from the follicle walls.  $\times 35$



Fig. 13 No 9099 Granulosa cell cancer of the ovary. The characteristic granulosa epithelium *GE*, with its rotundity and uniformity and its round deep staining nuclei forms the main structural component of the tumor parenchyma. The continuity of the epithelial mass is broken here and there by round or oval spaces the remnants of follicles *F* or by islands of ovarian stroma *OS* which have not been displaced as yet.  $\times 30$

a full term normal child. The delivery and the puerperium were normal.

On June 8 1919 the patient stated that since her last delivery 2½ years ago she had menstruated but twice the last time on April 26 1918 and that since then she has had trouble with flashes dizziness and perspiration. Pelvic examination revealed a retroverted uterus and a cystic enlargement of the left ovary to the size of an adult fist. The rest of the pelvis and the abdomen were apparently free. Bearing in mind the pathological findings in 1919 (reported at that time by the pathologist as adenocarcinoma) I urged the patient to be again operated upon. My advice was not taken.

On September 21 1919 she returned complaining of progressive abdominal enlargement. On examination I found free fluid in the peritoneal cavity and an increase in the size of the left ovary which by this time was fixed in position. I reoperated on September 27 1919 but the condition was beyond surgical relief. A specimen was removed for microscopic study and the morphological findings were identical with those found in 1915 with the exception that at that time I have found signs of beginning necrosis. Nine months later the patient finally succumbed.

Clinically this case presents the following points of interest: (a) The comparative benignancy of this type of ovarian cancer, (b) the successive involvement of the ovaries, and (c) the complete restoration of normal men-

struation and fecundity after the removal of the diseased ovary. Histopathologically this case furnishes the following facts: From the morphological characteristics of the epithelial cells forming the parenchyma of the tumors, this neoplasm must be classified under the group of granulosa cell cancer and not as an adenocarcinoma as reported by the pathologist in 1915. While I did not find in this specimen histogenetic evidence, I did find arrangements and groupings of the epithelial cells similar to those observed in the preceding case—thus our modern concept of tumor evolution was substantiated. The histogenesis in this case was established on the facts brought out in the preceding study, although only faint indications of follicle like structures were seen in the solid portions of the tumor.

CASE 3 Path No 9055 J. A. aged 54 years VI para. The youngest child is 24 years old. The menopause began 7 years ago. On November 26 1928 patient began to bleed vaginally, and the hemorrhages have continued for the past 3 weeks.

Physical examination reveals a slightly relaxed vaginal outlet; cervix normal to sight and palpation, the uterus somewhat larger than normal for this period of life, slightly irregular in outline and firm in consistency, the left ovary the seat of a globular

hard tumor the size of an adult fist, and the right adnexa apparently normal

On November 28, 1928, I performed an abdominal panhysterectomy and a bilateral salpingo-oophorectomy. The postoperative recovery was uneventful.

Pathological examination discloses the following. The specimen (Fig. 8) consists of the uterus and its adnexa. The uterus measures 8.7 by 6 by 4.6 centimeters, it contains a few tiny interstitial fibroids, the walls are 5 centimeters thick, and a thin polyp extends from the fundus to the level of the internal os. The right adnexa are apparently normal. The left ovary, of solid consistency, measures 8.1 by 4.6 by 4.3 centimeters. Its outer surface is nodular and yellowish in color. The covering serosa is smooth and glistening. On cross section a distinct capsule can be noted, varying in thickness from 0.5 to 1 centimeter, and recognizable as ovarian tissue.

The endometrium (Fig. 9) is markedly hyperplastic, presenting besides a cystic dilatation, also an active secretion in some of the glands as indicated by the height of the columnar epithelium, and by the mucous and bloody contents in their lumina. The glands in the uterine polyp (Fig. 10) show a still more pronounced activity than that noted in the endometrium proper. Sections from the cortical portion of the left ovary show a rim of ovarian tissue, of different thicknesses, covered with a low cuboidal epithelium, harboring corpora albicantia, and in its mesial parts an invasion with granulosa cell cancer. Sections from the more centrally located portion of the tumor (Fig. 11) show an invasion of the stroma with granulosa like epithelium, which proliferates from the periphery of round and oval spaces of various dimensions. As these epithelial masses join with each other, the intervening stroma disappears, and solid clumps of granulosa cells form. The epithelial cells bordering on the ovuloid or folliculoid spaces occasionally take on a columnar form. The lumina of these spaces may or may not be filled with a pinkish staining homogeneous mass. Other arrangements and groupings of the granulosa cell cancer are found in the same tumor, either as branching strands, identical with the descriptions given by v. Werdt, and in other parts in the form of long strands made up of single rows of cells.

The histopathological facts in this case point to the granulosa surrounding the folliculoid and ovuloid spaces as the source of the tumor growth. I retain the term folliculoid and ovuloid cancer in this instance because the spaces found within the granulosa cell masses do not contain distinctly recognizable ovules, otherwise I would have called this phase of granulosa cell cancer as the follicular stage or the early stage in the development of this tumor. From Figure 11 we can also learn that these round and oval spaces are not morphological sequences to a unique form of

"liquefaction" as claimed by Robert Meyer but definite structures in which the only type of liquefaction found is within their lumina, which is also characteristic of normal ovarian follicles. The further histopathological phenomena presented by this tumor are identical with those already described.

This case also demonstrates once again the influence of growth on function. If my histogenetic claim is correct, that the epithelium forming the granulosa cell cancer is derived from the follicles, then the biological function inherent in these cells ought to manifest itself clinically in a renewed or an increased ovarian function, which would express itself through the uterine mucosa. In this case we found an hyperplasia of the endometrium and an onset of uterine bleeding long after the menopause had been established. The hyperactivity or renewed activity in the uterine glands was noted not only in the polyp, which is in itself an expression of growth stimulation, but in the endometrium as well. What stronger proof need be offered to show that there exists a close relationship between growth and function, between biology and pathology?

CASE 4. Path No. 2999. M. F., aged 36 years, came under my care on May 7, 1925, complaining of a rapid increase in the size of her abdomen within the past 5 weeks. Menses began at 13 years, were four weekly in type, and painless and moderate in amount. The last period occurred 14 months ago. She has given birth to four full term normal children, the last one 5 months ago.

Physical examination reveals the abdomen enlarged and bulging due to the presence of free fluid, the pendulous part of the abdominal wall oedematous. No masses are palpable. On vaginal examination a tumor the size of a goose egg is felt in the left iliac fossa. The uterus and the right adnexa are apparently normal. Douglas's cul de sac is bulging as a result of the free fluid in the peritoneal cavity, but no nodules are felt.

On May 8, 1925, I performed an abdominal panhysterectomy, bilateral salpingo-oophorectomy, and appendectomy. Besides the free fluid there were no evidences of any metastases.

Pathological findings are as follows. The uterus and the right adnexa are normal. The left ovary is the seat of an oval shaped cystic tumor, measuring 9.5 by 6 by 5.5 centimeters. Its outer surface is smooth and shiny, the color grayish yellow, and the walls rather thick. On cross section the cyst wall shows two distinct layers: an outer, denser, of grayish tint, and an inner, softer one of a yellowish color and wavy outline. Sections from the outer layer

show a great deal of ovarian tissue that is edematous and engorged. Of the generative elements, corpora fibrosa and albicantia predominate in some parts, while in others a considerable number of follicles is present (Fig. 12). These follicles show a marked proliferation of their granulosa which extends outward into the stroma. Some of the follicles are moderately cystic, contain ova and in some instances the germinal spots are still discernible. The tumor proper (Fig. 13) is composed of dense areas of round epithelial cells with dark staining nuclei, of striking uniformity, showing no mitosis or degeneration. The continuity of the epithelial invagination is broken here and there by oval or round spaces, the remains of follicles or by islands of ovarian stroma which has not as yet been displaced.

In June, 1925, this patient received a postoperative course of deep X-ray treatment. Repeated vaginal abdominal examinations made every 4 weeks up to January, 1926, proved to be negative. During this period of observation the patient has gained in weight and has felt well, except for the vasomotor disturbances induced by the surgical menopause. Her breasts continued to secrete milk freely for 8 months after the operation. Since January 1927 I have lost track of this patient. Inquiries failed to show her death record so I assume she is still living.

The histopathological criteria found in this case leave no more room to doubt the histogenesis of granulosa cell cancer. Up until now I have followed the precautions taken by other authorities and have called the oval and the round spaces found in granulosa cell cancer, folliculoid or ovuloid formations because I failed to find absolute proof of the identity of these structures to follicles. With the finding of unmistakable ova in these spaces and with the demonstration of the granulosa proliferations from their circumference, the final histogenetic proof is established. We can therefore state now with absolute conviction that the granulosa epithelium forming the parenchyma of this type of ovarian cancer takes its origin from the follicles and not from hypothetical embryonal rests, and that the round or oval spaces present, even when devoid of normal or recognizable intrafollicular contents, are not the result of a process of "liquefaction" or of "degeneration" not even of a possible "reversion to type" by the granulosa epithelium, but the remains of real follicles.

#### SUMMARY AND CONCLUSIONS

1 The morphological truth enunciated by Rokitsansky 75 years ago that the epithelium

forming this unique type of ovarian cancer is of the granulosa variety, is fully substantiated.

2 The histogenetic hypothesis that the granulosa hyperplasia starts from embryonal rests, the rete ovarii, and the medullary rays, must be renounced, because the morphological facts brought forth in this study show that the structural origin is the granulosa of the already formed follicles and because the presence of these assumed embryonic rests do not exist in the adult human ovary.

3 The presence of easily recognizable ova in the round and oval spaces in granulosa cell cancer establishes their morphological significance and makes the terms "folliculoid" and "ovuloid" hitherto employed, superfluous. The fact that in many of these spaces no trace of ova is found does not warrant such terms as "liquefaction," "regression," or even "reversion to type."

4 I agree fully with those authorities who contend the impossibility of postnatal follicular proliferation, but disagree with those who deny that the follicle epithelium possesses metaplastic and hyperplastic potentialities. For if other types of epithelium in their function are secreting or protective structures may from time to time exceed their normal growth limitations and form benign or malignant tumors why cannot the granulosa epithelium with its rich proliferative endowments become the seat of similar morphological disturbances?

5 The classification of granulosa cell tumors into cylindroid, folliculoid, solid, and other types is only confusing. They are not different tumor entities but different growth phases in the evolution of the same tumor. In describing the morphology we ought to indicate these phases, which would simplify tumor nomenclature.

6 The outstanding morphological differences between the granulosa cell cancer and other forms of carcinoma are (1) The uniformity of the proliferating epithelium, particularly during the early stages of the neoplastic development, (2) the absence of mitosis, with rare exceptions, (3) the absence of infiltrative and destructive tendencies, and (4) the spreading of the tumor by continuity and extension and not by way of the lymphatic or blood streams.

7 As confirmative evidence of the histogenetic truth of granulosa cell cancer is the power of the proliferating epithelium to augment the function of the still active endometrium, or to reawaken its functions after it has been dormant for some time, by virtue of an increase of the ovarian hormone content in the blood. This clinical observation made by me, was also noted by H. O. Neumann, Robert Meyer, Mullersheim, Walthard, and O. Frankl.

#### PAPILLARY CARCINOMA AND PAPILLARY ADENOCARCINOMA OF THE OVARY

The theoretical dissensions about the origin and classification of papillary carcinoma and papillary adenocarcinoma of the ovary are not less numerous and contradictory than those which prevail in the chapters on granulosa cell cancer. Thirty years ago Orth propounded the following questions: (1) Do the simple and the papillary cysts, lined with ciliated or non-ciliated epithelium, have the same origin? (2) Do they start from the germinal epithelium (i.e., the surface epithelium), or from follicle epithelium? (3) Are embryonic rests of the ovary, or of the wolffian body, to be considered as the genetic sources? To these three pertinent questions I would add a fourth: Are all surface papillomata continuations of the intracystic growths?

The literature antedating Orth's publication and that which has appeared since then represents a continuous academic dispute. Which are the kernels of scientific truth in this welter of recorded investigation?

Since Klebs and Waldeyer have proved that ovarian cysts do not form as a result of colloid degeneration of the ovarian stroma but that they are the products of epithelial metaplasia, numerous studies have been undertaken to ascertain which of the epithelial depots in the ovary is the genetic soil—the germinal epithelium, the assumed embryonal rests, or the follicle epithelium. Waldeyer and Nagel were among the first to deny the embryonal rest theory, because as already stated, these structures disappear from the ovary soon after its differentiation into the sex gland. Waldeyer believed that through the invagination of the surface epithelium neo-

plasms may develop within the ovary. Amann, Frommel, Klebs, v. Kahlden, Nagel, Steffek, Stratz, Sampson, and many others are firmly convinced of this genetic possibility. And while many have promulgated the theory of inflammation as a predisposing factor to this invagination of the surface epithelium, Sampson in his masterly contributions has proved this supposition to be an uncontroversial fact.

As early as 1879 Marchand stated that all papillary cysts of the ovary arise from follicles or from structures simulating follicles, which in turn were formed from the surface epithelium, covering the lateral parts of the ovary. Among the recent observers who have espoused Marchand's postulate are Steffek and Stratz, all others refute it.

The contemporary dean of gynecic pathology, Robert Meyer, stated in unequivocal terms "no cystomata can arise from follicles." Goodall wrote "To my mind there is not one case in the literature of a graafian follicle that is supposed to show developing papillomata, that will stand the test of scientific criticism."

According to these eminent investigators, the follicle epithelium must be discarded as a possible genetic source of papillary growths. A still more divergent and extraordinary histogenetic theory of epithelial tumors in the ovary is that of Walthard. He wrote "The squamous, the ciliary, and the goblet epithelium forming the corresponding ovarian neoplasms, arise neither from the surface epithelium or its antecedents, nor from the follicle epithelium and its precursors, nor from the embryonal rests of the primordial kidney, but from congenital anlagen of squamous, of ciliary, and of heaker cells." He stated further "the development of proliferating ciliary, squamous, or heaker cell adenomata is conditioned not alone upon the corresponding type of misplaced epithelial rests, but also upon their accompanying stroma, derived from the differentiated ovarian connective tissue. Without its stroma these different types of epithelium would degenerate, and the spaces formed as a result of this regressive metamorphosis would have been filled with normal ovarian stroma."



Walthardt's dictum that each type of epithelial tumor in the ovary arises from a corresponding congenital anlage, surpasses all morphologic speculations and is contrary to the accepted laws and observations formulated and recorded by Marchand, Malasses, de Siney, Fleischlein, Fischel, Lauche, and many other recognized authorities. Walthardt's theory must be considered as the fantasy of a great but lone observer.

I am certain that all these contradictory views would have been reconciled long ago, and Orth's questions regarding the histogenesis and classification of benign and malignant papillary tumors of the ovary would have been answered by this time, more satisfactorily than has been done up to the present, if those who labored so assiduously in this field, would have heeded his admonition, that "we cannot draw histogenetic conclusions from fully formed tumors." I have demonstrated the soundness of this warning in my study of granulosa cell cancer and expect to prove it once more in the case of papillary tumors of the ovary.

#### HISTOPATHOLOGICAL AND CLINICAL FACTS IN PAPILLARY CARCINOMA AND PAPILLARY ADENOCARCINOMA OF THE OVARY

CASE 1 Path No 3533 L. L. aged 59 years, married 15 months nullipara. Menses began at the age of 13 years were three weekly in type of 2 to 3 days duration moderate in amount and painful. The last period occurred on November 7 1925. Her chief complaints on November 25 1925, were back ache for the past 2 years worse during menstruation pain in the lower abdomen and sterility.

Physical examination discloses a well nourished normal female. The abdomen is enlarged by a cystic tumor which extends from the xiphoid cartilage down into the pelvis. The outlines of the tumor are irregular and its consistency varies from softness to semisolidity. The vaginal outlet is normal. The uterus is of normal dimensions and is held forward by the lower pole of the tumor. Another cystic tumor the size of a grape fruit which is not palpable abdominally occupies the right iliac fossa.

On November 8 1925 I performed a supracervical hysterectomy and a bilateral salpingo-oophorectomy. There were no metastases or free fluid in the peritoneal cavity. The postoperative recovery was uneventful.

Pathological examination shows the following: The uterus is somewhat smaller than normal at this age otherwise negative. Both ovaries are converted into cystic tumors pearl gray in color the outer sur-

faces of which are studded with small papillary growths. On cross section they present a honey-combed appearance formed by the walls of the daughter cysts, which in turn bear papillae on the interior. The more solid portions of the tumors consist of a yellowish gelatinous substance which fills the cyst cavities. The fallopian tubes lie stretched across the anterior surface of each ovary. The neoplasm is a papillary adenocarcinoma (Fig. 14, No 3073), in which the papillary type predominates. The epithelium covering the papillae or lining the adenomatous spaces is for the most part columnar, not ciliated in type. Here and there we note that next to distinctly malignant cells are low cuboidal microscopically benign cells. Sections from areas of the cyst wall, with surface and interior papillae opposite each other at almost the same spot (Fig. 15 No 3073) showed no structural continuity between the two. The intervening ovarian stroma forming the cyst wall is not invaded by the malignant epithelial metaplasia, and the lymphatics as well as the blood vessels are also free from metastatic involvement. We may also note an abrupt transition of the normal epithelium on the surface of the ovary into a malignant form. The serosa covering the fallopian tubes (Fig. 16, No 3533) is thrown into folds which carry along with them connective tissue stalks forming papillae and adenomatous spaces and showing in the covering epithelium, also a sudden transition from a normal to a malignant state.

The histopathological findings presented in this and other cases are (a) a sudden transition from a microscopically normal epithelium to a distinctly malignant form, (b) the structural independence between the surface and the interior papillae, (c) the evident genetic source of the surface epithelium and lack of evidence regarding the source of the interior epithelium (for we do not know as yet how this epithelium has found its way into the depths of the ovary), and (d) the fact that the epithelium covering the fallopian tubes also manifests a papillary formation simulating that noted in the ovaries. This last finding has led to the conclusion that these epithelial centers must have had a common genetic soil and that they are both capable of responding to the same growth stimulant.

CASE 2 Path No 3446 R. B., age 65 1 para. The youngest child is 20 years old. On February 16 1928, patient complained of heaviness in the lower abdomen backache and frequent urination.

Physical examination discloses moderate relaxation of the vaginal outlet. The cervix is short, is pressed upward against the symphysis pubis by the lower pole of a cystic tumor which extends upward

from the pelvis to a point 2 inches above the umbilicus. The left ovary is palpable and is apparently normal.

On February 17, 1928, I performed a supracervical hysterectomy and a bilateral salpingo oophorectomy. No ascites or metastases were present. The postoperative recovery was uneventful.

Pathological findings were as follows. The specimen consists of a small atrophic uterus lying between two ovarian tumors. The right neoplasm is the size of a fetal head, grayish in color, and is alternately thick and thin in consistency. The outer surface is smooth except at points where it was adherent to adjacent structures. The left ovary is twice the normal size and contains a few microcysts.

The right ovary is the seat of a papillary adenocarcinoma, which differs in no way from the classical type. The left ovary (Fig 17) is the seat of an apparently benign adenoma. Some of the gland spaces show the beginnings of papillary formations. The columnar epithelium in some of the glands shows some unrest, perhaps early malignant changes. We also note a few primary follicles in the cortical portion of the ovary. In another section we find a large irregular cystic cavity (Fig 18) with a tuft of papillae projecting into it. The lining epithelium of this space differs from a very low cuboidal, to a distinct columnar type, which dips into the underlying stroma at various points of the circumference. There are also areas (Fig 19) in which a structural continuity between the surface epithelium and the adenomatous spaces is seen. Note how an epithelial fusion takes place between these two epithelial deposits, and at the same time the independent formations of surface and interior papillae.

On June 20, 1928, this patient returned complaining of repeated attacks of abdominal cramps. An examination disclosed a tumor mass the size of a fist in the posterior fornix. The previous pathological findings have influenced my clinical judgment, and I have diagnosed the case as a metastatic intrapelvic tumor, although no other masses or free fluid were present. Deep X-ray therapy was instituted at once. A re-examination on October 18, 1928, showed that the tumor mass felt originally in the posterior fornix was now much higher and more freely movable. My diagnosis of metastases from the ovarian carcinoma was now abandoned and I re-operated on October 22, 1928, and instead of finding an intraperitoneal cancer mass, I found an adenocarcinoma of the sigmoid flexure (Fig 20). The peritoneal cavity was free from metastases. A resection of the affected intestine was performed. The patient developed a fecal fistula, and the long stay in bed debilitated her already exhausted state of health, and she succumbed about 6 weeks later.

The histopathological findings and the clinical data in this case throw valuable light on the problems of the histogenesis of papillary ovarian tumors, upon epithelial metaplasia, and upon the multicentric origin of new-

growths. The morphological facts in Figure 19 show how the surface epithelium has found its way into the ovarian interior, thus paving the way for papillary and adenomatous formations. In Figure 18 we note the growth of papillae into a cystic space which must have been a cystic follicle, although it can no longer be identified as such. This suggests another genetic source for papillary growths, namely, the follicle epithelium. But I shall not force this genetic issue until more positive histopathological facts can be adduced.

Both ovaries are affected with papillary adenomatous metaplasias, malignant in the right and benign in the left. This difference in the nature of these fundamentally identical tumors must be explained on the ground that additional histobiological and biochemical factors must have arisen in the right gland, which have brought about this change. And it is my opinion that in time the same malignant condition would have arisen in the left ovary as well. This statement is not an histopathological prophecy based on assumption, but a well founded fact supported by repeated clinical observations. Many of us have had to remove the second ovary months or years after having removed the first one for malignancy, diagnosed at the time of the operation or subsequently, although at the time of the primary operation the ovary not removed looked and felt normal.

This case presents also data bearing upon the autochthonous development of the ovarian and the sigmoid carcinomata. The distinctly different types of cancer in each instance, excludes in a large measure their common origin. If the ovarian cancer were secondary in nature, its spread from the intestine could have taken place only via the lymphatic or blood streams, or by continuity and contiguity. Microscopically, I did not find any invasion of either of these carriers. Clinically not the slightest evidences of adhesions between the pelvic organs and the sigmoid were present at the time of the first operation. At the second operation the peritoneal cavity showed again freedom from metastases and the tumor bearing portion of the sigmoid was freely movable, and the muscularis of the intestinal wall also failed to show carcinomatous

invasion. In view of these facts, we can state that this patient's immunity to cancer had been lowered, and she was, therefore, apt to develop carcinomata in more than one place, independent of lymphatic or blood vessel transportation or of continuity or contiguity.

**CASE 3.** Path No 10172. E. G. aged 37 years. Menses began at 14 years, were of the 25 day type, painless up to 3 years ago and profuse most of the time. The last period occurred on January 23, 1919. Since her childhood she has been complaining of indefinite pains in the right lower quadrant of the abdomen. For the past few years she is conscious of a movable abdominal mass.

Physical examination discloses a well nourished individual the heart and lungs are normal. The abdomen contains a hard irregular freely movable tumor. Rectoabdominal palpation suggests the diagnosis of multiple uterine fibroids.

On February 5, 1929, I removed five interstitial fibroids, the right uterine adnexa, and the appendix. The postoperative course was uneventful.

The pathological findings were as follows. The enucleated fibroids vary in size from a grape fruit to a hen's egg. The right ovary is slightly enlarged, bluish in color, cystic in consistency and covered with a smooth glistening serosa. The cyst wall consists of a broad strip of ovarian stroma, somewhat edematous, moderately infiltrated with lymphocytes (Fig. 21), covered with a layer of cuboidal and partly columnar epithelium showing distinct carcinomatous metaplasia which dips into the underlying stroma and invades it from without. The tumor proper consists of the usual adenocarcinomatous growth. The mucosa of the right fallopian tube (Fig. 22) also shows a marked epithelial unrest. In some spots the basement membrane is broken through and next to apparently normal single layered epithelial cells we see irregular multilayered columnar epithelium with mitotic figures. The underlying stroma is mildly infiltrated with lymphocytes. The lymphatics and blood vessels of the tubal wall are free from cancerous invasion.

On February 24, 1929, I removed the uterus and the left adnexa. No evidences of metastases were present. The recovery from the second operation was also smooth and uneventful. Deep X-ray therapy was instituted on the fifteenth day after the second operation. The patient is well, except for the vasomotor disturbances which are treated endocrinologically.

Pathological findings were as follows. The uterus is normal in appearance except for the scars on its outer surface caused by the myomectomies. The walls are thickened and measure 6.5 centimeters. The endometrium shows marked hyperplasia for a distance of 2.5 centimeters on the lower part of the left wall. The left adnexa appear to be normal. On cross section the left ovary shows a recent corpus luteum of menstruation, otherwise normal.

The corpus luteum is in the stage of vascularization, and of the other generative elements we find a few corpora fibrosa primary and secondary follicles. At the meeting point of the cortical and medullary portions of the ovary a few areas are present showing typical granulosa cell cancer (Fig. 23) in the form of solid masses infiltrating and displacing the stroma, or spreading from the periphery of cystic follicles into the stroma. The mucosa of the left tube also showed some cellular unrest but not as pronounced as in the right. The area of endometrial hyperplasia noted macroscopically (Fig. 24) shows a distinct adenocarcinomatous hyperplasia and metaplasia next to which lies an apparently normal endometrium except for a mild degree of cystic dilatation of some of the glands.

This case illustrates once again the fact of multicentric autochthonous development of carcinoma in the generative tract. In the right ovary we have found a distinct type of adenocarcinoma, with papillary formations in some areas. In the left ovary is a typical granulosa cell carcinoma. The mucosa of the uterus and the left fallopian tube have also participated in the cancerous metaplasia and so did the serosa of the ovary. These findings speak for a primary cancer of the generative tract, affecting its lining, covering, and parenchymatous epithelium, all of which emanate from a common genetic soil. The morphological variations noted in the affected epithelium in the various subdivisions of the generative tract are due undoubtedly to the differentiations which the original colomic epithelium has undergone in the different sections of the tract in the process of organic formation, as well as to local conditions which greatly influence morphology.

**CASE 4.** Path No 3785. J. F., aged 33 years. III para. The youngest child is 3 years old. Menses began at 16 years, were of the 28 day type of 4 to 5 days duration moderate in amount and painless. The last period occurred on January 28, 1928. Her chief complaint on February 15, 1928, was pain in the right side of the abdomen.

Physical examination disclosed tenderness over the gall bladder region, and a multilocular cyst of the left ovary as large as a grape fruit.

On February 24, 1928, I performed a supracervical hysterectomy, a bilateral salpingo oophorectomy, appendectomy and cholecystectomy. The patient left the hospital on the fourteenth day after the operation, feeling well.

The pathological examination showed the following. The gall bladder measures 15 by 8 centimeters, the walls are thickened, and it is filled to capacity.

with faceted stones of various sizes. The appendix is normal. The left ovary is the seat of a cystic tumor the size of a grape fruit, covered with many papillary growths. The right ovary is normal in size, contains a few follicle cysts, and shows tiny papillae on its outer surface.

The neoplasm in the left ovary is a typical papillary adenocarcinoma, with hardly a trace of recognizable ovarian tissue. In some of the sections normal looking epithelium lies next to the definitely cancerous tissue, a phenomenon which I have repeatedly observed. Sections from the right ovary (Fig. 25) show a great deal of tissue which can be identified as ovarian in structure, many cystic follicles lined with several layers of granulosa epithelium and surrounded by a well developed theca externa, which is readily differentiated from the surrounding ovarian stroma by its lighter color and looser texture. Some of the cystic follicles show a papillary formation (Fig. 26) which can be traced from their earliest stages of development, indicated by tiny folds of the lining of the follicles to fully formed true-like growths. The mucosa of the left fallopian tube also shows a precancerous stage and the serosa of the left salpinx shows papillary formations of a definite character. The same phenomenon is also observed in a cystic subperitoneal cavity of the fallopian tube.

The pertinent histopathological facts in this case are (a) the presence of papillae in a cystic follicle, (b) the simultaneous participation of different epithelial depots in the papillary metaplasia, besides the ovary, namely, the serosa of the fallopian tubes, and the endosalpinx, (c) the structural independence of the surface from the interior papillae, and (d) the presence of normal epithelium close to distinctly malignant cells.

#### SUMMARY AND CONCLUSIONS

1. Contrary to Robert Meyer's teachings that neither follicles nor any part of them can be a genetic source of tumor formation, I hold with Marchand that they can and do give rise to granulosa cell cancer and to papillary growths of a benign and a malignant character. I believe that this is the first study in which Marchand's claim is verified and substantiated with histopathological facts.

2. The traditional teachings that the surface papillae are continuations of intracystic growths could not be supported by my findings, which show their respective independent development from the outer and the inner layers of epithelium covering and lining the cyst walls.

3. The participation of the covering and the lining epithelium of the fallopian tubes and the uterus in the benign and malignant papillary and papillary adenomatous formations in the ovary, demonstrated the common genetic soil of all these epithelial centers, their equally inherited biological potentialities, which respond to the same growth promoting stimuli, thus undergoing an almost similar morphological change.

4. The finding of benign looking epithelial cells adjacent to cells which are definitely malignant, in papillary adenocarcinoma, indicates first, that the cancer cells are evolved from previously (microscopically) normal ones, and, second, that this seemingly sudden transition must in reality be a gradual one, although we cannot detect with the ordinary means employed, the finer intermediary stages that lead up to the morphological identification of malignancy.

5. The autochthonous, multicentric, and simultaneous occurrence of different types of primary cancer in the generative tract, as exemplified in this study, presupposes a multiplicity of cancer hormones acting concurrently. Some hormones are capable of arousing both the epithelium and its underlying stroma to form papillae and papillary adenoma, others activate the parenchyma only and form granulosa cell cancers.

#### METASTATIC CANCER OF THE OVARY

We have been taught for many years that cancer may metastasize to the ovary via one of the following routes (a) by continuity, (b) by contiguity, (c) by implantation, and (d) by way of the lymph and blood vessels. Ribbert, Oeffergeld, Schottlander, and others have drawn very fine distinctions between the processes of continuity and contiguity, claiming that in the former process adhesions form between the adjacent organs and that along these bridges of tissue the cancer cells are transported, while in the latter event the migration of the malignant cells proceeds without the intervention of tissue continuity. The last conjecture is hardly believable, for in my experience I have found that the apparent "macroscopic contiguity" has proved to be a "microscopic continuity." I cannot imagine

cancer cells traversing through space like the pollen of flowers and becoming implanted by this process in remote lying tissues and organs. It is my opinion that the concept "contiguity" may be dismissed from the subject of cancer pathology without sustaining a scientific loss.

The theory of "implantation" postulates that particles of cancer tissue may separate themselves from their primary base, such as the gastro intestinal tract, and be carried to the surface of the ovary by the peristaltic waves in the abdomen, and become implanted, in what Schauta termed, the physiological defects caused by the process of ovulation. My own clinical experience does not support the theory of "implantation," for in outspoken cases of metastatic ovarian carcinoma secondary to gastric and gall bladder malignancy, I could find cancer particle not on the surface of the ovaries, but in the lymphatics of the interior.

The soundest of all theories formulated about the manner and method of cancer metastasization is the one of the lymph and blood vessel routes, and this theory is easily and frequently verified. In fact, some authorities admit of no other possibility. For a time pathologists could not explain how cancer of the upper abdomen could metastasize to the ovaries via the lymph and blood vessel streams, for in such an event a reversion or back flow in the circulation must occur. Pfannenstiel and Schottlander admitted the occurrence of this vicious cycle and have termed it "retrograde transportation," which is now universally accepted.

Kehler and Amann described the mechanism of "retrograde transportation" as follows: "The lymphatics of the stomach empty into the retrogastric lymph glands, from here the lymph is carried to the superior lumbar glands, which also receive the lymph channels from the ovaries. It is from the lumbar glands that a retrograde flow to the ovaries takes place." The damming back of the lymph stream takes place according to Recklinghausen and to Borst because of a mechanical obstruction formed by cancer particles in the proximal lymph and venous channels. Those of us who have examined tissues affected sec-

ondarily with cancer can readily grasp the possibility of this occurrence.

Clinically all these theories on the spread of carcinoma avail but little in making a positive diagnosis of secondary ovarian carcinoma on the operating table. We find quite often unilateral or bilateral solid or semisolid ovarian tumors with smooth, intact outer surfaces, not adherent to any other organ or structure, and without any perceptible local evidences of malignancy, and we cannot decide from the macroscopic appearance of the tumor whether it is a primary and still less a secondary carcinoma. In the majority of such instances, a diagnosis of primary carcinoma is made, and we feel content that the malignant tumor has been radically removed, particularly if we remove the uterus and the opposite adnexa with it. But how often is this clinical impression or opinion reversed by subsequent histopathological studies, or by autopsy findings, which show that we have been dealing with a condition of secondary instead of primary ovarian cancer. Have we any guides which will lead us out of this clinical perplexity?

Kroemer offers as a diagnostic aid in the differentiation between primary and secondary ovarian carcinoma, the presence of enlarged retroperitoneal lymph glands and the freedom of the peritoneal cavity from cancer involvement. These are indeed valuable signs, but I have encountered instances in which the involvement of the retroperitoneal glands has been so slight as to escape our palpatory sense, and concerning the peritoneal involvement I have shown that while the serosa may appear normal macroscopically, it shows advanced involvement when subjected to microscopic examination. These diagnostic aids are therefore of little value at the time of greatest importance, namely the time of operating, for if we are dealing with a secondary condition, it would be foolhardy to attempt radical procedures which may result in immediate fatality. On the other hand, if the ovarian cancer is primary, operative risks are more justifiable, for in some instances life has been prolonged for many years after a thorough removal of the primary focus. A correct diagnosis is also of inestimable importance, for experience has taught that in uni-



Fig 14 No 3973 Papillary adenocarcinoma of the ovary. At *N*, the epithelium covering the papilla still has a normal appearance, while at *M* it is definitely malignant. The transition of the papillary into the adenomatous type is shown at *Aden*, where the surface epithelium burrows its way into the underlying stroma and forms glandular structures.  $\times 30$

lateral primary ovarian cancer, it is best to remove the opposite apparently normal ovary

#### HISTOPATHOLOGICAL AND CLINICAL STUDIES OF SECONDARY OVARIAN CANCER

CASE 1 Patb No 1282 D F, aged 33 years, came under my care on May 6, 1923, complaining of a progressive enlargement of the abdomen for the past 8 months and of attacks of cramp like pains in the epigastrium. Patient had been married 14 years, was a IV para. The last child was born 8 months ago. She also miscarried once 14 years ago. Menses began at 14 years, were of 6 to 7 days' duration, moderate, and painless. The last period occurred before the last conception in January, 1922. Patient was operated for acute mastitis in December, 1922, and for a left inguinal hernia in March, 1923. She stated that at the time of her last operation, 3 months ago, the surgeon did notice an abdominal tumor, but did not consider its removal as urgent.

Physical examination reveals the following a thin, frail individual with an enlarged abdomen containing a great deal of free fluid and two globular tumors in the lower half. The tumor on the left reaches a height of 2 inches above the umbilicus, and the one on the right extends slightly below the umbilicus. The vaginal outlet is relaxed, the cervix is lacerated, and the lips are everted and eroded. The uterus is normal in size and outline, anteverted, and wedged in between the two globular tumors. The smaller tumor occupies the hollow of the sacrum, and the larger one is in front and to the left of the uterus.

On May 7, 1923, I performed an abdominal pan hysterectomy and a bilateral salpingo oophorec-

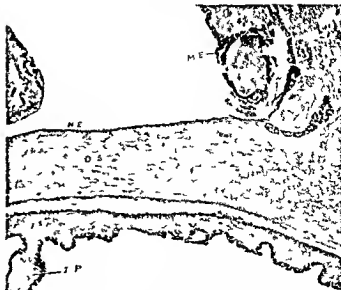


Fig 15 No 3973 Papillary adenocarcinoma of the ovary. Part of the cyst wall composed of ovarian stroma, *OS*, which is normal, the outer surface is covered with a low cuboidal normal epithelium at *NE*. To the extreme right there springs a surface papilla, *SP*, covered with malignant columnar epithelium, *ME*. The internal papilla, *IP*, take their origin from the lining epithelium of the cyst, and have no structural connection with the surface growths.  $\times 35$

tomy. The peritoneal cavity contained a large quantity of free serous fluid. No visible or palpable metastatic nodules were present in any part of the abdominal cavity. The postoperative recovery was uneventful.

Pathological findings were as follows. The specimen (Fig 27) consists of the uterus and its adnexa. The ovaries are converted into heavy, solid globular tumors, of an irregular wavy outline, covered with a smooth glistening serosa. The left tumor is as large as a coconut, while the right one as big as an adult's fist. On cross section, the tumors present a very dense structure, of a yellowish color. The fallopian tubes lie stretched across the upper anterior surface of each ovary and look normal. The uterus has also a normal appearance. The epithelium covering the ovaries is normal, low cuboidal in form. Most of the identifiable follicles contain degenerated ova. The ovarian stroma (Fig 28) is oedematous, and many of the lymphatic spaces are dilated and filled with plugs of cancer tissue. The endometrium is normal, but the muscularis (Fig 29) is invaded with cancer either in the form of single cells lying in the tissue clefts or as large cancer nests within the lymphatics. The cervix is normal. The fallopian tube (Fig 30) also shows a marked cancerous invasion of the submucosa and the tubal wall, but the lining epithelium is normal.

Soon after the diagnosis of ovarian cancer (without any designation by the pathologist as to its primary or secondary nature) was established, prophylactic deep X ray therapy was instituted, in the hope



Fig. 16 No. 3433 Fallopian tube in a case of papillary adenocarcinoma of the ovary. The serous surface is thrown into small and large folds carrying the underlying stroma with it and forming papillae. The serosa also dips into the tube wall and forms adenomatous spaces.  $15 \times 35$ .

that the case was one of primary ovarian cancer. In January, 1924 patient showed a gain of 30 pounds in weight felt well, except for the vasomotor disturbances caused by the surgically induced menopause. A physical examination of the abdomen and the pelvis at this time failed to disclose any evidences of recurrence anywhere. A second vaginal and abdominal examination made in May, 1924 also proved to be negative but she complained of slight discomfort in the epigastrium after meals. After this visit the patient refused to return for further

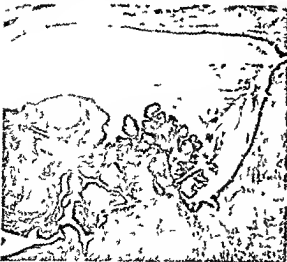


Fig. 18 No. 2346 A large cystic space within the substance of the left ovary lined with low cuboidal and columnar epithelium, with a tuft of papillae projecting into its interior the opposite ovary being affected with an adenocarcinoma.  $\lambda_{30}$ .



Fig. 17 No. 2346 Benign papillary adenoma of the left ovary the right one being the seat of a papillary adenocarcinoma.  $\times 30$ .

observation. My last inquiry concerning her progress brought the information that she was operated on for a supposed acute cholelithiasis at the Wyckoff Heights Hospital Brooklyn, in September, 1924 and a carcinoma of the head of the pancreas was found. She died in that institution shortly after

This single case contains an abundance of theoretical and practical knowledge pertaining to the subject of primary and secondary ovarian cancer. At the time of the operation I diagnosed the case as one of primary ovarian cancer, and the pathologist was in apparent



Fig. 19 No. 2346 The surface epithelium fuses with the epithelium of the adenomatous spaces. In the interior a large surface papilla having no structural continuity with the papillae forming within the deep adenomatous spaces.  $\times 40$ .



Fig. 20 No 8346 Carcinoma of the sigmoid, removed 6 months after an operation for primary adenocarcinoma of the right ovary. The intestinal wall, I W, is not involved.  $\times 35$

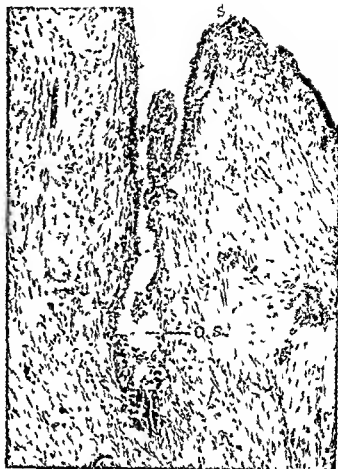


Fig. 21 No 10173 Papillary adenocarcinoma of the ovary. The serosa, S, shows a malignant metaplasia. It dips into a surface crypt and invades the ovarian stroma, O.S., from without.  $\times 45$

accord with the clinical impression. Although bilateral involvement should have suggested the possibility of a secondary character, notwithstanding the fact that the primary focus was not visible or palpable, I was rather influenced in my judgment by the macroscopic findings, and have considered the case as one of primary ovarian cancer. The reason for this error is the same as that which misleads other abdominal surgeons, namely, that the largest tumor is considered as the primary focus. In most instances this clinical assumption is justified, but not in secondary ovarian carcinoma. O. Frankl has called our attention to the clinical fact that ovaries secondarily affected with carcinoma may attain dimensions which exceed by far the size of the primary cancer focus, and I may add long before the primary focus gives rise to physiological disturbances. This case illustrates the



Fig. 22 No 10173 A cross section of a fallopian tube associated with an adenocarcinoma of the corresponding ovary. Note transition of lining epithelium from a benign B to a malignant M stage. Lymph spaces and blood vessels in tube wall are free from cancerous invasions. There is a moderate lymphocytic infiltration in submucosa.  $\times 37$





Fig. 23 No 4151 Granulosa cell cancer of the left ovary in a case in which the right ovary was the seat of a papillary adenocarcinoma. Note the large follicular cyst F and the proliferation of the granulosa cells from its walls into the surrounding stroma.  $\times 35$



Fig. 24 No 4151 The endometrium in a case in which the right ovary was the seat of papillary adenocarcinoma and the left ovary affected with granulosa cell cancer. At MF malignant epithelium while at VE the epithelium looks normal.  $\times 30$

soundness of these claims. The carcinoma of the pancreas from which this patient died 1 year after the removal of the ovarian cancer, must have been so small in size that it gave no evidences of physical or functional disturbances, yet it was capable of producing massive metastasis in the ovaries.

Not only do the dimensional disproportions between the primary focus and the secondary growth in the ovaries mislead us clinically in making a correct diagnosis, but pathologists are often guilty of perpetuating this error, by not stating definitely in their reports whether the ovarian cancer was primary or secondary. It has also happened to me that when the pathologist has stated the nature of the ovarian cancer his opinion has been reversed by subsequent findings. Can we be certain as to whether an ovarian cancer is primary and secondary?

My investigations have shown that secondary ovarian cancer is characterized by the non participation of the epithelial elements of the generative organs in the cancer metaplasia. The cancer tissue in secondary ovarian, tubal, and uterine carcinoma, is located within the lymph spaces or blood vessels of the stroma, and the lining epithelium of these organs presents a normal appearance. It is only in the very advanced stages of the cancer

metaplasia in the invaded organs that a correct pathological diagnosis becomes difficult, in the earlier stages, however, the differentiation between primary and secondary carcinoma of the generative organs should not present a problem.

Are there any clinical signs and symptoms indicating or suggesting the type of ovarian cancer? If there is any tangible relationship between growth and function, and if tumors assume the function of the organs from which they spring, then ovarian cancer ought to furnish a most illuminating example of this morphobiological concept. In granulosa cell cancer, and to a much lesser degree in papillary adenocarcinoma of the ovary, we have noted an increase of the present ovarian function or its revival after it has been suspended for a short or long interval of time. In secondary ovarian cancer on the other hand, even when the tumors have reached large dimensions, the ovarian function remains undisturbed, or

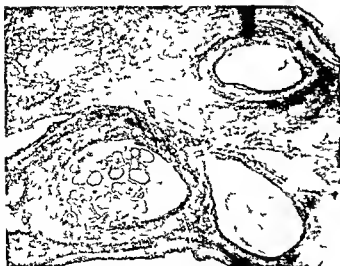


Fig 25 No 3785 The left ovary from a case in which the right was the seat of papillary adenocarcinoma. Note the cystic degeneration of the follicles, each of which is surrounded by a distinct theca externa. The largest follicle cyst shows a papillary proliferation from the lining mucosa toward the lumen. In the other cystic follicles the granulosa cells are still recognizable  $\times 10$

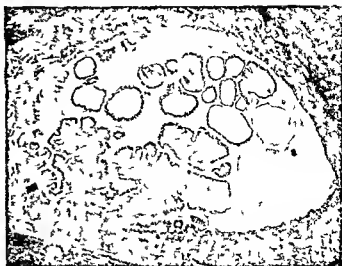


Fig 26 No 3785 Papillary and papillary adenocarcinoma in a cystic follicle. Under higher magnification the granulosa character of the lining epithelium is discernible at the extreme left. At other points of the circumference we can note the earliest beginnings of papillary formations, which are gradually enlarging to bigger dimensions  $\times 15$

is undergoing gradual extinction. The case presented here illustrates this fact. This patient was only 33 years of age, and at the time of the operation for the ovarian carcinoma, 17 months after her last confinement, the menses had not been re established and she did not nurse her infant. It is true that in granulosa cell cancer, we have found in some instances an increase in the ovarian function, or its reappearance in women in whom the menses have not occurred for some time. I believe that these clinical phenomena should serve us in making a differential diagnosis between primary and secondary ovarian cancer.

#### GENERAL CONCLUSIONS AND DEDUCTIONS

1 The histogenetic source of granulosa cell cancer is the epithelium of the graafian follicles, and not the problematic fetal rests, the medullary rays, and the rete ovarii, which do not exist in the ovaries of human adults.

2 The folliculoid, the medullary, and the solid forms of granulosa cell cancer are not different cancer types, but different growth phases in the evolutionary process of one and the same tumor.

3 The outstanding morphological differentiations between the granulosa cell cancer and other types of ovarian carcinoma are (a) the rotundity and uniformity of the epi-

thelial cells (during the early phases of the tumor growth), (b) the rarity of mitosis, and (c) the absence of invasive and destructive propensities in the granulosa cancer.

4 Primary ovarian cancer, particularly the granulosa type, may augment the still active ovarian function or revive it after it has been quiescent for a short or long period of time, which manifests itself clinically by an hyperactivation of the endometrium, resulting in an increase of the normal menstrual flow, or in the reappearance of periodic uterine bleeding after the establishment of the menopause. Secondary ovarian cancer does not influence the ovarian function at first, but later on, as the disease progresses, it has a tendency to suppress it progressively, as the volumetric proportions of the cancer metastases rise.

5 The differences in the influence which primary and secondary ovarian cancer have respectively upon ovarian function, emanate from the differences in their histopathology. As the primary ovarian cancer is a derivative of the generative elements in the ovary, such cancer is endowed with the same hormone producing properties as the parent tissue, so that with an increased hyperplasia of this type of tissue, the hormonal index rises. On the other hand, the epithelium in secondary



FIG. 27 No 1252 Metastatic carcinoma of the uterus the ovaries and the tubes

cancer of the ovary is of an extra ovarian genesis, and therefore it has no relationship to ovarian function which it leaves either uninfluenced or annihilates it in the course of time through the physical destruction of the generative elements in the ovary

6 As a corollary to the structural and functional relationship observed in primary ovarian cancer (granulosa), it would seem worth while to test the blood of patients suffering from ovarian neoplasms for an increased or diminished content of ovarian hormone, as an aid in the differential diagnosis between primary and secondary malignant affections of the sex gland

7 The histogenetic sources of benign and malignant papillary tumors and papillary adenomatous tumors of the ovary are the surface epithelium of the ovary the epithelium lining its cyst cavities and the epithelium of cystic follicles. This fact overthrows the dictum that follicles do not give rise to neoplasms

8 The simultaneous formations of benign and malignant papillary formations within cystic follicles, ovarian cysts and upon the surface of the ovaries and the similar affections of the lining epithelium of the uterus and the fallopian tubes, and of the epithelium covering these organs substantiates and verifies the common genetic source of all these variously located and metamorphosed epithelial centers which are equally influenced by the same biological factors

9 Surface papillae may be the continuations of intracystic growths which have perforated the wall, but in all my studies I have found them to be independent growths arising



FIG. 28 No 1283 Secondary cancer of the ovary. Ovarian stroma is edematous the cancer nests are within the lymph spaces X75

from the outer layers of the cyst wall and its overlying epithelium

10 The finding of normal epithelium adjacent to malignant in papillary tumors, would lead us to assume that the transition from a benign to a malignant state is a sudden one, for we cannot detect by the ordinary microscopic means employed the finer biochemical changes that ensue within the cells before the structural features of malignancy become patent in reality, however, this transition is a gradual one. Biochemical tests and not morphological criteria will have to determine early malignancy in the future

11 The clinical assumption that the ovarian cancer is primary because the surface epithelium is intact and because the ovarian tumor is not adherent to any of the adjacent organs or tissues is ill founded. On the contrary, in most instances these findings indicate metastatic carcinoma, and the abdominal surgeon should attempt to find the primary focus

12 The extension of the papillary growth from the ovarian surface to neighboring viscera should not discourage us from proceeding with a thorough removal of the tumor if consistent with safety, for in many instances radical conservatism has yielded the most gratifying results

13 In view of the successive nature of primary ovarian carcinoma, it is imperative



Fig 29 No 1282 Uterine wall in a case of secondary carcinoma of the ovaries. The lymph spaces are distended with large cancer plugs, and single cancer cells are also seen in the tissue interstices  $\times 75$



Fig 30 No 1282 Fallopian tube in a case of metastatic cancer of the ovaries. The epithelium covering the villi is normal and the cancer deposits are within the small and large lymph spaces of the tube wall and submucosa  $\times 50$

to remove the opposite ovary and the uterus when operating for an apparently unilateral ovarian malignancy

14 The prognosis of ovarian cancer in general may be based upon the histopathological observations made by McCarty, Martzloff, and others, namely (1) cell differentiation, (2) lymphocytic infiltration, (3) fibrosis, and (4) hyalinization. Accepting these morphological criteria as prognostic guides, I have found that the granulosa cell cancer is the most benign for we seldom find in it mitosis, lymphocytic infiltration, or fibrotic or hyaline degeneration. The absence of these phenomena is easily explainable, it does not signify a paucity or lack of defensive mechanism by the host, for these structural phases are defense mechanisms but a benignancy of the cancer. The close morphological resemblance of the granulosa cell carcinoma to the granulosa of the follicles does not make the proliferation of these cells quite foreign to the ovarian tissue, hence no necessity for defense reactions. The biological phenomena associated with granulosa cell cancer and its clinical course further substantiate its comparative benignancy.

In papillary adenocarcinoma of the ovaries, the prognosis is by far less favorable. The neoplastic tissue is morphologically further removed from its genetic source than the

granulosa type of cancer. Its invasion of the surrounding tissue is, therefore, resisted more forcibly. The defense mechanisms are mobilized much more intensely, and we find a marked lymphocytosis. The degree of the lymphocytic reaction varies with the degree of differentiation of the proliferating epithelium. Hyalinization and fibrosis I did not observe in papillary adenocarcinoma of the ovaries.

15 Metastatic ovarian cancer is the most malignant, the reactions in the ovaries are most pronounced, and the removal of the ovaries does not eradicate the root of the disease.

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# A BACTERIOLOGICAL STUDY OF THE VALUE OF MERCUROCHROME AS A VAGINAL ANTISEPTIC WITH PARTICULAR REFERENCE TO ITS USE IN OBSTETRICAL CASES<sup>1</sup>

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**D**URING the past 20 years comparatively little attention has been paid to the sterilization of the birth canal preparatory to delivery, and there has been no general marked change in the morbidity and mortality figures. De Lee (1918) has stated that one woman in every 400 deliveries succumbs to infection and ten times this number remain incurable invalids. Statistics show that one-third of the mortality in the United States is due to puerperal infection.

An increasing amount of data, however, is tending to show that the birth canal is frequently contaminated by pathogenic organisms. Thus, Joetten (1912) examined 100 cases and found that streptococci, which often were of the hæmolytic type, were present in 67 per cent of the vaginal secretions.

Fricke (1914), working under Williams, examined 97 patients. Of 50 clinic patients, streptococci were found on the vulva in 14 per cent and in the vagina in 8 per cent. Forty-seven patients were examined in their homes and the vulva found to be contaminated with streptococci in 75 per cent. The vagina was similarly contaminated in 55 per cent of the cases. The low figures in the first series were attributed to the use of unsuitable culture medium.

Burt-White and Armstrong (1928) took vaginal cultures from 153 pregnant women and succeeded in isolating streptococci in 23.5 per cent of the cases. Organisms were obtained in 35.9 per cent under anaerobic culture conditions. Of these, many were hæmolytic.

Bigger and Fitzgibbon (1925) similarly examined swab material from the vaginas of 158 women, either on admission or shortly afterward. In the majority of these cases labor had already commenced. Streptococci were present in 101 cases, but the hæmolytic type was found only twice in 108 specimens.

The authors believe that the commonest form of puerperal sepsis is due to exogenous infection.

A study of cultures taken from 50 uteri at cæsarean section by Harris and Brown (1927) gave positive results in 22 cases. In 13 of these patients, there had been no vaginal examination. The membranes had ruptured in 15 cases prior to the operation. The authors are of the opinion that every patient in labor for more than 6 hours should be considered potentially infected, since they were able to obtain pathogenic organisms from the uterus in all such cases.

Alhert (1927) reports 20 cases in which cultures were taken from the placenta and fetal membranes immediately following cæsarean section. All the placenta cultures were negative. The decidual cultures were all positive except one. In 7 cases, streptococci, staphylococci, and pneumococci were found.

Harris (1922) reported the results of histological examinations of 60 uteri. In 23 of the specimens there was definite evidence of ascending infection, and many of the stained preparations showed bacteria. These figures deal with late removal after a trial delivery. Further investigation showed that the number of infections depended on the length of labor.

A large percentage of amputated uteri showed acute inflammation of the decidua according to Williams (1917).

The work of Johnson and Siddall (1922) tends to show that the generally accepted preparation of today is not what it should be.

Walthard (1919) reported that positive cultures were obtained from amniotic fluid and uterine secretions in 15 cases at cæsarean section.

In the report (1923) of the Committee of the Massachusetts Medical Society, on maternal and infant welfare, it is stated that approximately one half of the deaths which

<sup>1</sup>This study was made possible by the income of the Lindridge Research Fund.

TABLE I—PRIMIPARÆ VERSUS MULTIPARÆ

	Primiparæ		Multiparæ	
	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens
Vagina	97	9.28	83	2.41
Cervix	97	5.25	83	3.61
Membranes	73	6.10	67	7.46

usual. These plates were incubated as before. In 23 of the 25 controls there was no perceptible difference in the amount of growth of the staphylococcus which appeared in the smeared area and that which appeared beyond it. In two cases the growth within the smeared area was very slightly less than that beyond, so little less, however, that it was considered negligible and large colonies developed in these areas also. It was, therefore, concluded that so little mercurochrome was carried over to the plate that it would not inhibit the growth of any living organisms which might be present.

#### CULTURED SWAB MATERIAL

Swab material taken from the skin of the perineum before the use of mercurochrome and cultured gave pathogenic organisms in 83.3 per cent of the cases. Pathogenic bacteria were similarly found in the vagina in 44.7 per cent, and of 55 cases in which material from the cervix was examined, 18.1 per cent yielded pathogens.

Results from the culture of perineal and labial swab material after the use of mercurochrome and following delivery may not be so reliable since there is a possibility of contamination of the perineum by discharge of feces and shifting of sterile dressings. In 140 cases, however, cultures were taken from the skin in this region following delivery, and 25.0 per cent gave pathogens. In 100 cultures similarly taken from the labia pathogens were shown in 28 per cent of the cases. The labial region is often carelessly prepared, the depth of the folds interfering with proper cleansing.

The pathogenic organisms referred to in the tables included staphylococci, streptococci, and bacillus coli.

Non pathogenic organisms also were found at times. These organisms consisted largely of yeast and the bacillus vaginalis.

Only pathogenic organisms are considered in this report.

It should here be pointed out that the apparent discrepancies in some of the tables dealing with the pathogenic bacteria found in different sites are due to the fact that it was often impossible to get a complete set of cultures from each patient.

#### PRIMIPARÆ VERSUS MULTIPARÆ (TABLE I)

There was a greater number of pathogenic bacteria found both in the cervix and vagina when the cultures were taken from the primiparæ, while in the cultures from the membranes, there were more positive pathogens in the multiparæ. With the primiparæ the labor is usually longer and more likely to be operative, while in the multiparæ the labor is of short duration, the cervix is likely to be dilated and lacerated and very often the seat of chronic infection. This would possibly account for the higher percentage of pathogens obtained in the membranes.

#### VAGINAL VERSUS RECTAL EXAMINATIONS (TABLE II)

From 11 patients there was only one positive pathogen found in 30 cultures taken following vaginal examinations. This may be due to the fact that during the vaginal examinations, the perineal preparation, as well as the instillation, is repeated. There was a low percentage of organisms following rectal examinations. This series included a large majority of the spontaneous deliveries, while the cases with vaginal and rectal examinations included the cases of prolonged labor and other evidences of dystocia. The cases with no examinations showed the highest average of pathogenic bacteria. This is due to the fact that the labor was usually short and that the mercurochrome was in

TABLE II—VAGINAL VERSUS RECTAL EXAMINATIONS

	Examination vaginal		Examination rectal		Examination vaginal and rectal		No examinations	
	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens
Vagina	11	0	125	1.6	51	21.21	11	18.18
Cervix	11	9.09	125	4.0	53	3.01	11	9.09
Membranes	8	0	95	8.42	25	0	12	8.33

TABLE III—DURATION OF LABOR

	Duration of labor in hours									
	0 to 6		6 to 12		12 to 18		18 to 24		Over 24	
	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens	Cases	Per cent positive pathogens
Vagina	39	2.56	45	8.22	50	8	21	4.76	25	16
Cervix	39	2.56	45	8.83	50	2	21	4.76	24	4.16
Membranes	20	17.24	37	9.7	30	5.13	16	6.25	10	0

stilled too near the time of delivery. It is impossible to instill a patient properly when the cervix is retracted past the presenting part or if the presenting part is on the perineum. The solution will not remain in the vagina nor does it come in contact with the cervix or the upper part of the vaginal mucosa. Referring to Table V it will be noticed that the percentage of positive pathogens was 18.18 per cent in 11 cases which were instilled at the time of delivery.

At the present time we are making a comparative study of the effect of vaginal and rectal examinations on the morbidity following the use of the mercurochrome technique. This will be published later.

#### DURATION OF LABOR (TABLE III)

The number of positive pathogens found in the vagina increased with the duration of labor possibly due to the contamination from without. The patients almost invariably put their hands on the perineum during labor, as is shown by the stain on their fingers. Bed clothes and rectal examinations may also tend to contaminate the perineum as labor progresses. At the hospital we use no protective perineal dressing during labor. With the cervical cultures there is an increase during the second 6 hour period, but then a marked

drop to 2 per cent followed by a slight increase to between 4 and 5 per cent for those cases in labor over 18 hours. With the membranes there were 17.4 per cent pathogens when labor was less than 6 hours, again due to the fact that the mercurochrome did not have a chance to reach the membranes. There was a marked drop in the second 6-hour interval and in 36 cases in labor over 18 hours, only one positive pathogen was recovered.

#### RUPTURED MEMBRANES (TABLE IV)

With the vaginal cultures there was a steady increase in the pathogens found up to 18 hours, and in 36 cases with the membranes ruptured over 18 hours only one pathogen was found. In the cultures from the cervix the maximum number of pathogens was found at 12 and 18 hours, but in 36 cases with the membranes ruptured over 18 hours, there were only two positive pathogens. Cultures taken from the membranes showed that the greatest number of pathogens was recovered in the period from 6 to 12 hours and in 34 cultures when the membranes were ruptured in from 12 to 24 hours, only one positive pathogen was found.

Ruptured membranes have been considered one of the great factors in the production of morbidity. This is undoubtedly true when



## CONCLUSION

These results undoubtedly prove that mercurochrome does reduce the bacterial content of the birth canal during labor, and even though the membranes are ruptured and labor prolonged, if the mercurochrome is instilled regularly and properly, the number of pathogens apparently does not increase either in the cervix or the membranes

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## SODIUM AMYTAL-NITROUS OXIDE ANÆSTHESIA FOR THYROIDECTOMY

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**S**ODIUM amytal (sodium iso amyl ethyl barbiturate) has been introduced recently as an anæsthetic agent, and a comprehensive clinical trial of it is still in progress. We wish to present our opinion as to the advantages which appear to result from the sodium amytal nitrous oxide combination in thyroidectomy and as well to tabulate the patients' reaction during and after administration. The first few experiences with anæsthesia from this drug convinced us how necessary it is to have a high degree of control over the anæsthetic agent. No matter what anæsthetic agent is used or in what manner it is administered, controllability is of first importance. For this reason just enough sodium amytal was given to induce sleep and nitrous oxide gas and oxygen were used to control the depth of anæsthesia.

From comparatively small doses of sodium amytal a light sleep was induced which was sufficient for preparation and preliminary measures. During actual operative manipulations nitrous oxide gas with an unusually high component of oxygen was given. The cyanosis, which is often a part of satisfactory nitrous oxide anæsthesia, did not occur when a proper amount of sodium amytal had been given. In our opinion this manner of using sodium amytal and nitrous oxide gas makes an ideal anæsthetic agent when marked relaxation is not necessary for the successful performance of the operation. Because of the flexibility of control and because of the absence of both anæsthetic depression and irritation of the respiratory tract, the combined use of sodium amytal and nitrous oxide gas seems particularly well adapted to operations

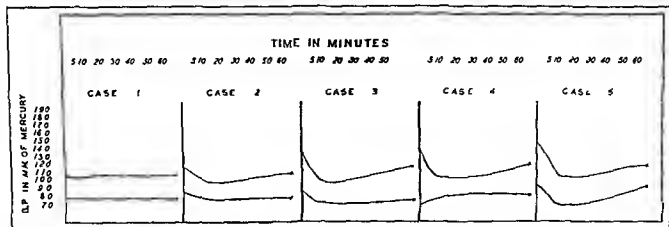


Fig. 1. Illustrates changes in blood pressure observed during intravenous administration of sodium amytal injection of which occupied the initial 10 or 15 minutes on each curve. Blood pressure at completion of operative procedure is also indicated.

upon the thyroid gland and upon the chest, because marked relaxation of the muscles is not important. At least in so far as we are aware, these desirable features are not combined to the patient's advantage when any other anæsthetic agent is used. We have found in our experience that ethylene is constantly followed by a distressing degree of laryngeal irritation and a most disturbing amount of mucus, in fact, this complication appeared so constantly in greater or lesser degree when ethylene was used that for a time we felt that some part of the operative technique was at fault. With ether anæsthesia the same complication occurred at times but not regularly. While opinion differs widely as to the cause of this complication, it is agreed that it occurs frequently and is most undesirable. In this series of cases the presence of laryngeal mucus as a postoperative complication occurred only twice and then in mild forms.

We have used sodium amytal combined with nitrous oxide anæsthesia in 135 general surgical cases and in this report we wish to analyze in detail 27 consecutive cases of thyroid surgery performed with this type of anæsthesia. The series consists of 26 thyroidectomies (subtotal) and 1 double polar ligation performed at the Robert W. Long Hospital from February to August, 1929.

Sodium amytal was administered intravenously to 23 of these cases and by rectum in the 4 others. Table I contains a summary of the dosage employed. The dose of the drug

given intravenously varied from 12 to 20 milligrams per kilogram of body weight, however, the majority received approximately 15 milligrams per kilogram (1 grain per 10 pounds body weight). Variations from the average dose were made at the time of injection in accordance with the patient's reaction to the drug. Considerable latitude in dosage was found necessary due to individual differences in reaction. Effectiveness was observed to vary with age, general health, and rate of metabolism, and the dosage required to induce a light sleep in each patient was best determined by the rate at which the subject became unconscious at the time of injection.

The drug was given by rectum in 4 instances and by this route a dosage of from 20 to 30 milligrams per kilogram was used. There is much to commend this method of giving the drug, but in the event that a portion of the dose is expelled subsequent dosage is difficult because the amount retained cannot be reckoned exactly. Also in the event of undue depression, the intravenous method is by far the safest, since the effect by this method is essentially instantaneous and the administration may be stopped immediately. If given rectally the removal of the drug would be a difficult if not an impossible procedure.

All these patients received in addition to the sodium amytal a pre-operative dose of morphine—10 to 15 milligrams ( $\frac{1}{6}$  to  $\frac{1}{4}$  grain). This was combined with 0.5 milligrams of atropine sulphate ( $\frac{1}{150}$  grain) in 8 instances.

TABLE I--REACTION OF PATIENTS DURING AND AFTER SODIUM AMYTAL INJECTION

Case No	Sex and age	Diagnosis	Basal metabolism	Dose of sodium amytal		Nitrous oxide oxygen %	Remarks
				Milligrams per kg	Total dosage in grains		
				Intravenously	Per rectum		
1	F 39	Adenoma	-7 -7	25		25	
2	F 34	Adenoma	+12	25		25	
3	F 29	Adenoma		25		25	
4	F 52	Adenoma		25		0	Post operative auricular fibrillation
5	F 45	Adenoma	+14	12		22	Digitalized for auricular fibrillation pre-operatively. Slight fibrillation developed after operation
6	F 30	Exophthalmic	+62 +38	22		7	Only polar ligature done due to fast pulse rate
7	F 53	Adenoma	+61 +33	12		15	Postoperative auricular fibrillation
8	F 30	Exophthalmic	+33	25		0	See Case 6. Thyroidectomy at this time
9	F 52	Adenoma	+30 +26	25		20	
10	M 43	Exophthalmic	+17	18		15	
11	F 35	Adenoma	+12 +18	15		12	
12	F 43	Adenoma		25		15	
13	F 42	Adenoma	+41 +31	25		15	
14	M 41	Exophthalmic	+73	15		12	Postoperative auricular fibrillation. Reaction to intravenous normal saline
15	F 28	Adenoma	+27 +27	15		14	
16	F 45	Adenoma	+15 +30	15		14	Partially digitalized for control of auricular fibrillation pre-operatively. Fibrillated after operation
17	F 31	Adenoma	+26 +21	15		24	
18	M 10	Exophthalmic	+41 +03	18		15	
19	M 27	Exophthalmic	+19 +27	20		21	
20	F 35	Adenoma	+12	15		14	
21	F 24	Adenoma	+22 -5	15		10	
22	F 24	Adenoma	- 8		25	22	
23	F 18	Adenoma	+41 14	14		17	
24	F 27	Adenoma	+20		27	24	
25	F 26	Adenoma	- 2		30	25	
26	M 23	Adenoma	- 0	15		14	
27	F 26	Adenoma	9		20	10	

The patients received the sodium amytal in bed while they were still in their rooms and fell to sleep naturally without noticeable excitement or apprehension. When given into the vein it was administered immediately before the operation and from one to one and a half hours prior when given rectally. The drug was prepared fresh in 10 per cent solution by mixing dry crystals with triple distilled water. When the intravenous method of administration is used, considerable circulatory depression is observed if the rate of injection exceeds 100 milligrams per minute.

In this series 10 to 20 minutes were allowed for the injection.

Observations of the blood pressure during the intravenous administration of the drug were made in a few cases of this series, and showed a rather constant fall, amounting on the average to 25 millimeters of mercury in the systolic and 10 millimeters in the diastolic readings, during the time of injection. After the injection had been completed, a rise of from 15 to 20 millimeters was usually observed, and in all cases the pressure was maintained at approximately a normal level.

throughout the operation. Figure 1 illustrates the different types of reaction which were encountered in our series. Case 2 is the most typical.

Transfer to the operating room was accomplished with the patients in a light sleep and free from excitement.

Nitrous oxide gas and oxygen were used as a supplementary anæsthetic. It was found that relatively low percentages of this gas produced satisfactory anæsthesia. The great majority of cases received from 75 to 85 per cent nitrous oxide, and a few as low as 65 to 75 per cent. With such mixtures, excellent anæsthesia was maintained on these patients and cyanosis was completely eliminated with one exception. This patient (Case 6), a young woman acutely ill with toxic thyroid symptoms, had a double ligation of the superior poles. A slightly larger dose of sodium amytal would have been more effective.

Immediately after the operation the patients began to awake slowly and the effect of the amytal was fortified by small doses of morphine to produce a quiet sleep from which they could be aroused if necessary. When awakened they co-operated in a rational manner. Also there was freedom from nausea and vomiting which is frequently observed in the operating room after operation following nitrous oxide and ethylene anæsthesia. No evidences of postoperative mania or excitement were encountered. Prolonged sleep did not occur after any of these anæsthetics.

The postoperative course in general was good in this series. There were no deaths. The pulse rates were elevated to 130 or 140 in most instances, in only two cases were rates as high as 150 seen. Temperatures varied from 100 to 102.5 degrees, a few were as high as 103 degrees. In one patient a reaction occurred following the intravenous injection of normal salt solution, and during this time a temperature of 108 degrees was reached.

The only complication seen was auricular fibrillation which occurred in 5 cases. All of these were controlled satisfactorily with digitalis.

#### SUMMARY

In this small series of thyroid cases, we believe that the pre-operative preparation of the patients with comparatively small doses of sodium amytal (seldom exceeding 15 grains) renders the patients free from apprehension of the anæsthetic and the operation. In addition adequate anæsthesia is obtained with smaller amounts of nitrous oxide and a proportionately larger amount of oxygen, thus largely obviating cyanosis. Also the post-operative course of the patients is free from nausea, vomiting, and laryngeal mucus.

Since it is highly desirable to have as much control as possible of the anæsthetic agent, we believe that the intravenous method of administration affords the greatest degree of flexibility when loss of consciousness is desired.

## THE EFFECTS OF SODIUM AMYTAL

ON LIVER FUNCTION, THE RATE OF SECRETION AND COMPOSITION OF THE URINE, THE REACTION, ALKALI RESERVE, AND CONCENTRATION OF THE BLOOD, AND THE BODY TEMPERATURE<sup>1</sup>

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THE therapeutic usefulness of barbituric acid derivatives as hypnotics was first demonstrated by Fischer and Mering in 1903. The one under consideration, iso-amyl ethyl barbituric acid, commonly called amytal, was first prepared in 1923 (Shonle), and has been used as a laboratory anæsthetic for the past 7 years (5, 10). Recently, Zerfas, McCallum, Shonle, Swanson, Scott, and Clowes have shown that it may also be used as a general anæsthetic in man. Amytal was first employed clinically at Indianapolis (12, 20, 21) and at present is being used in many clinics. Its increasing use, therefore, makes it desirable to know as much as possible concerning its more intimate pharmacological actions. Accordingly, we have investigated the effects of the substance upon the functions of the liver and kidneys, the reaction, alkali reserve, and concentration of the blood, and the body temperature in dog and man.

## LIVER FUNCTION

The method employed for testing the function of the liver was that of Rosenthal and White, which depends upon the removal of bromsulphthalein from the blood by the liver. The results are shown in Table I. In the experiments upon dogs the doses of amytal varied from 40 to 60 milligrams per kilogram of body weight. In the first 3 of these the sodium salt was prepared in the laboratory and given intraperitoneally, whereas, with the remaining 10, the drug used was the already prepared salt, administered intravenously. It will be seen that in only two instances was there as much as a 20 per cent retention of dye in the blood 24 hours after amytal, in the majority there was very much less. Normal animals show about 5 per cent dye retention. It will also be seen that there is no evidence of delayed liver damage. In

the human cases (done at the Western Division, Montreal General Hospital), in spite of the fact that small quantities of inhalation anæsthetics were used in each, there was no dye retention 24 hours after the administration of 1 gram of amytal.

These results show that so far as hepatic function is concerned, amytal compares well with some of the inhalation anæsthetics. Rosenthal and one of us (2, 14) have compared the effects of chloroform, ether, nitrous oxide, and ethylene on the liver, using the dye method. The action in the case of chloroform is particularly marked. Chloroform impairs liver function for 8 days when given for half an hour and for 6 weeks when administered for 2 hours. When anæsthesia is produced by ether, liver function is only slightly depressed after 24 hours (15 per cent dye retention) and is again normal after 48 hours. Relatively, then, and of practical importance, the harm done by sodium amytal to the liver would seem to be negligible.

## RATE OF SECRETION AND COMPOSITION OF THE URINE

Six experiments were conducted on dogs with bladder fistula, according to the method of Stehle and Bourne. The urine was collected as it was secreted, urea determined by the method of Stehle and phosphorus and chlorine by the micro method of Pregl. Table II is an example of the results obtained in the 6 experiments. In four instances 60 milligrams per kilogram and in two 50 milligrams per kilogram of amytal were used. Administration was by vein in all cases but one, in which the drug was given intraperitoneally. It will be seen that anuria does not occur but that there is a very definite degree of oliguria. The quantity of urea excreted per minute by the kidney is lessened, but its

<sup>1</sup>Read by invitation before the Montreal Medical-Chirurgical Society on April 25, 1930.

percentage is increased Phosphoric acid excretion is always increased, sometimes to a much greater extent than in the protocol given Variations in chloride excretion are more irregular than in the case of urea, but in general resemble the latter

Some observations have been made on man at the Western Division of the Montreal General Hospital The bladder was emptied and washed the evening before operation The urine passed thereafter was kept and added to that obtained at the next catheterization, just before the administration of the drug Catheterization was repeated shortly after the operation, and again 24 hours later It will be seen from Table III, which is a fair example of three such experiments, that the results obtained resemble those with dogs

It is evident that little or no damage is done to the kidney, for although there is an oliguria and a reduction in the quantities of urea and chlorine excreted, yet there is a percentage increase in these materials, which would imply active kidney function It will be shown below that sodium amytal produces a blood dilution which would ordinarily be expected to cause an increased urine flow That the opposite occurs is difficult to explain at this time The decrease may merely be the result of a lowered blood pressure

These results are somewhat different from those obtained with ether (18) In ether anaesthesia there is complete anuria or very marked oliguria Urea and chlorine excretion are so much depressed that in spite of the oliguria the concentrations of these substances also diminish The increase in phosphoric acid which occurs following both ether and amytal anaesthesia is more marked in the case of the latter and is probably, as in ether anaesthesia, involved in the acidosis now to be described

TABLE I—SODIUM AMYTAL ON LIVER FUNCTION

Experiment No	Dog No	Dose per kilo gram	Route	Time blood was withdrawn following amytal injection	Dye retention
1	15	50	Intraperitoneally	hours 24 66	per cent 20 — 5
2	18	50	Intraperitoneally	24 42	20 — 10
3	19	50	Intraperitoneally	24 90	10 10
4	22	40	Intravenously	24	— 5
5	23	40	Intravenously	24	— 5
6	22	50	Intravenously	24 72 168	10 15 — 5
7	23	50	Intravenously	24 72 168	— 10 — 10 — 5
8	24	55	Intravenously	25 66	— 5
9	25	55	Intravenously	25 66	10 — 5
10	24	60	Intravenously	24 72	— 5 — 5
11	25	60	Intravenously	24 72	15 — 10
12	22	60	Intravenously	24 72	— 5 — 5
13	23	60	Intravenously	24 72	— 5 — 5

## HUMAN

1 Male 64 kilograms Appendectomy 1 gram sodium amytal some nitrous oxide and a little ether Morphine before and after No dye retention in 24 hours

2 Male 68 kilograms Trephining and curetting humerus 1 gram sodium amytal some nitrous oxide and oxygen Morphine before and after No dye retention in 24 hours

3 Female Double salpingo-oophorectomy 1 gram sodium amytal some nitrous oxide and a little ether Morphine before and after No dye retention in 24 hours

administration of amytal, the blood bicarbonate increases to a slight extent, except in one instance in which it rose from 39.5 volumes per cent to 53.7 volumes per cent In this case, however, the dog was markedly anæmic (corpuscle volume 23.9 per cent) In every case following the administration of amytal, the hydrogen-ion concentration of the blood increased, the pH values falling 0.1 to 0.2 unit This increase in the hydrogen-ion concentration of the blood is maximal about 1 hour after the drug is given, but in one experiment it had not begun to fall again at the sixth hour Hines, Boyd, and Leese have also recorded a slight increase in the hydrogen-ion concentration of blood in amytal anaesthesia However, in their experiments

## THE REACTION AND ALKALI RESERVE OF THE BLOOD

The carbon dioxide combining power of the plasma was determined by the method of Van Slyke and Cullen and the hydrogen-ion concentration values by that of Dale and Evans Charts I and II show the results obtained It will be seen that following the

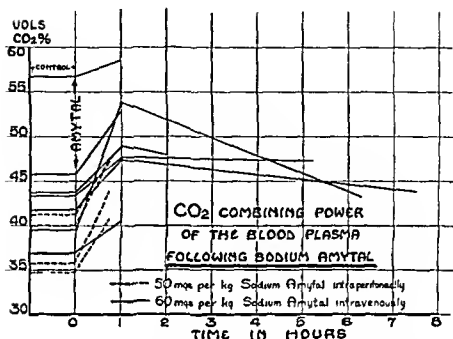


Chart 1

glucose solution was injected continuously. This may account for the somewhat smaller effects which they observed.

The acidosis accompanying amytal anesthesia differs from that observed in ether anesthesia in that the latter is accompanied by a lowered plasma bicarbonate while the former is accompanied by an increased bicarbonate. Some additional factor, therefore, seems to be involved in the acidosis of amytal anesthesia, which is not present, or at any rate important, in ether anesthesia. This factor may be the greater respiratory depression produced by amytal. Thus the high carbon dioxide tension of the blood may be

compensated in part by a migration of base into the blood. Experiments of Hjort and Taylor indicate that such a migration probably occurs in morphine narcosis in which respiratory depression is also profound. The increase in the hydrogen ion concentration of the blood is probably due in part to a disturbance in phosphoric acid metabolism as reflected by the increased phosphorus excretion. It is possible that investigation would reveal a concomitant increase of lactic acid in the blood, since the metabolisms of the two are very closely related.

Kochler, Brunquist, and Loevenhart have shown that anoxemia produces a more marked

TABLE II—URINALYSIS—BLADDER FISTULA DOG: WEIGHT 8.6 KILOGRAMS

Time	C cm per minute*	Mgms urea per minute	Urea Per cent	Mgms phosphorus per minute*	Per cent phosphorus	Mgms chloride per minute*	Per cent chloride
1:30—2:30*	562	25.225	4.476	439	0.750	184	0.317
2:40—3:40	167	10.403	6.002	536	3.007	065	0.105
3:40—4:40	160	9.208	5.793	075	27.31	040	0.150
4:55—5:55	140	6.683	4.774	205	1.467	235	1.600
(next day) 10:00—11:00†	057	3.492	6.163	126	1.226	033	0.581
2:30—3:30	080	5.459	6.824	093	1.119	092	1.157

\* 2:30—2:35 injection of 60 mgms per kilogram sodium amytal intravenously (5.16 c.c. of a 10 per cent aqueous solution)  
† At 11:00 a.m. 200 cubic centimeters of water was given by stomach tube

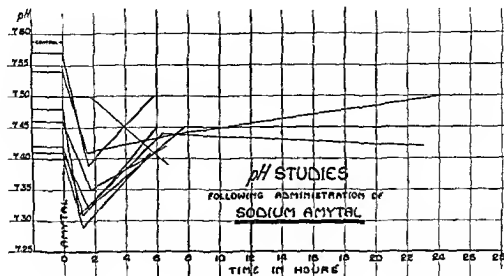


Chart 2

acidosis than has been observed in any other condition, but we cannot attribute the acidosis in our animals to this factor alone. In every case following the injection of amytal the condition of the dogs was observed closely, and upon the slightest sign of cyanosis, as evidenced by blueness of the tongue, oxygen was given intrapharyngeally, a good color being maintained throughout the experiment. We are inclined, therefore, to attribute the acidosis following the administration of amytal to phosphoric acid and possibly to lactic acid as suggested above, anoxæmia being a small and perhaps insignificant factor.

#### BLOOD CONCENTRATION

Blood solids were determined by weighing a small amount of blood, as drawn, before

TABLE III—URINALYSIS, CASE 2, MISS M, AGED 22 YEARS—APPENDECTOMY, RETRO-CÆCAL, DIFFICULT

Sample	Mgms urea per minute*	Mgms phosphorus per minute*	Mgms chloride per minute*	Remarks
Control period (12 hour sample)*	5.466	4640	791	
Anæsthetic period (4 hour sample)	3.792	3382	1.049	Supplemented by some ether & morphine or atropine
Post anæsthetic period (24 hour sample)	9.055	7752	1.005	Morphine gr 1/6 some water but no food

\* 1.5 grams sodium amytal in 10 per cent aqueous solution intravenously.

and after drying to constant weight at 110 degrees C. Corpuscle volume was determined by centrifuging oxalated blood in graduated tubes. Twelve experiments were done (Table IV) and with but a single exception, the blood showed a definite degree of dilution after the injection of sodium amytal, the maximum hydræmia occurring about 1 hour after the administration of the drug. The contrast with ether, which produces a marked blood concentration, is striking. Hines, Boyd, and Leese have reported increases in hæmoglobin in amytal anæsthesia, even when glucose solution was being administered. We are at a loss to explain this.

Frequently in the course of other work in this laboratory in which luminal was used as a general anæsthetic in dogs, it was noticed that the spleen often increased enormously in size, due, possibly, to an accumulation of corpuscles within it. It is possible that the same occurs with amytal (both drugs being closely related) thus decreasing the solid constituents of the circulating blood. In other words, the hydræmia following sodium amytal, far from implying an increase in blood volume, may actually imply a decrease. There may be some connection between such a decrease in blood volume and the oliguria noted earlier, but to explain the latter satisfactorily is impossible without further investigation.



TABLE IV

Blood solids per cent

Control	30.57
1 hour after amytal	29.53
2 hours after amytal	30.54
Control	30.75
1 hour after amytal	28.40
2 hours after amytal	28.95
Control	28.94
1 hour after amytal	28.94

Corpuscle volume per cent

Control	47.8
1 hour after amytal	47.6
2 hours after amytal	46.9
Control	47.31
1 1/4 hours after amytal	44.35
Control	44.07
1 hour after amytal	46.77
Control	46.01
1 hour after amytal	45.15
Control	47.60
1 hour after amytal	46.73
Control	45.9
1 hour after amytal	44.8
6 1/4 hours after amytal	40.9
Control	46.6
1 hour after amytal	45.2
6 1/4 hours after amytal	43.6
Control	45.3
1 hour after amytal	43.3
7 1/4 hours after amytal	35.2
Control	37.7
1 hour after amytal	37.8
5 hours after amytal	41.6
23 hours after amytal	47.5

Rectal temperature degrees centigrade

Control	39.5
15 minutes after amytal	39.4
1 hour after amytal	39.3
2 hours after amytal	39.2
Control	39.1
15 minutes after amytal	38.6
1 hour after amytal	37.6

## BODY TEMPERATURE

Deuel, Chambers, and Milhorat have shown that the administration of amytal produces a fall in body temperature from 2 to 3 degrees. During the course of our work, we have taken the rectal temperatures of our animals before and after amytal (Table IV) and can confirm this. Obviously, owing to the general quiescence of the animal and the decreased metabolism, a fall in body temperature is rather to be expected.

## SUMMARY

Sodium amytal has very little action upon liver function as determined by the bromsulphthalein test, comparing favorably with ether

in this respect. It depresses urine formation much less than ether. The combined carbon dioxide and the hydrogen ion concentration of the blood are increased, the former change being due possibly to the depressed respiration and the latter to disturbed phosphoric lactic acid metabolism. Hydræmia and a fall of body temperature also occur.

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# TRIBROMETHYL ALCOHOL (AVERTIN) ANÆSTHESIA<sup>1</sup>

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**P**RESENT day surgery requires a wide range of anæsthetic agents. In certain surgical procedures and in the presence of various pathological conditions, the desirability of general anæsthesia by rectal administration is quite evident. In 1923, Willstaetter and Duisberg succeeded in synthesizing tribromomethyl alcohol (known commercially as avertin), which is well adapted for this purpose. Over 150,000 cases of tribromomethyl alcohol anæsthesia have been reported in the European literature. From a review of these records and from our own experience it seems to us that we have acquired a valuable new anæsthetic for use in certain cases.

In tribromomethyl alcohol we have an anæsthetic which produces unconsciousness in a most satisfactory manner. When combined with light gas anæsthesia, the relaxation is usually adequate. The duration of the anæsthesia is sufficiently prolonged, and no unpleasant postoperative complications have been observed.

Without attempting comparisons with other anæsthetics, we believe tribromomethyl alcohol is entitled to a very high rating in respect to safety. Deaths have been reported under its use, but these were due almost entirely to improper administration and overdosage, both of which errors are now being eliminated by riper experience. While the relatively small number of our cases does not permit us to speak authoritatively, from our general experience with gas, ether, and their combinations, we do not hesitate to express the opinion that tribromomethyl alcohol is equally as safe.

Although ether anæsthesia produces unconsciousness, it apparently protects none of the brain cells against exhaustion from the trauma of operation. The anæsthetic gases are said to produce about one-fourth the exhaustion after equal trauma, according to Gwathmey. It is impossible to estimate the amount of damage inflicted by the psychic shock in some patients, particularly children, immediately preceding and during the induction

of anæsthesia. With preliminary morphine medication, the proper dosage of tribromomethyl alcohol, light gas anæsthesia, and infiltration with novocain, perhaps the most complete brain block is produced.

## DESCRIPTION

Tribromomethyl alcohol is a white crystalline substance, soluble in water at 40 degrees C (104 degrees F) up to 3.5 per cent. As the powder dissolves rather slowly in water, tribromomethyl alcohol is usually employed in the more convenient form of a concentrated solution in amylene hydrate, containing 1 gram in each cubic centimeter. If solutions are heated above 45 degrees C (113 degrees F), tribromomethyl alcohol decomposes by the liberation of hydrobromic acid and the formation of dibromacetaldehyde (a toxic irritant to the intestinal mucosa).

## PREPARATION AND ADMINISTRATION

The evening before operation a cleansing enema should be given. Special measures to empty the intestines on the day of operation should be avoided, as fluid in the bowel may retard absorption. Before the operation, morphine may be given as in preparation for gas anæsthesia.

The amount of tribromomethyl alcohol to be administered is calculated according to the weight of the patient. Our dosage has varied from 75 milligrams to 120 milligrams per kilogram of body weight, the average being 100 milligrams per kilogram. In estimating the dosage, the weight of the patient is taken as the index, and the dosage is then varied according to the experience of the anæsthetist. Routine calculation of the dosage on the basis of body weight should not be practiced. It has been found that children and young adults require relatively larger doses than older persons. On the other hand, the obese, the debilitated, the aged, and patients with impaired elimination should receive less than the average dose estimated by weight.

<sup>1</sup>Read before the Medical Society of the District of Columbia, December 21, 1919.

In preparing solutions, accuracy in every particular is essential. We have employed a 3 per cent solution, but a 2.5 per cent solution is now generally preferred. It is important that distilled water be used, and that the solution should not be subjected to a temperature higher than 40 degrees C. (104 degrees F). Otherwise tribromethyl alcohol is decomposed with the formation of hydrobromic acid and dibromacetaldehyde, which are very irritating to the intestine. Neither should the solution be allowed to cool, since this may cause crystallization of the drug and thus render the injection ineffective. The finished tribromethyl alcohol solution should always be tested before it is administered by adding to 5 cubic centimeters a few drops of a 1:1000 aqueous solution of Congo red. The resulting color should be a clear orange red, without any bluish or violet tint (the latter indicating decomposition).

One half hour before operation the solution of tribromethyl alcohol is introduced into the rectum by means of a small rectal tube. The tube is removed and the patient is allowed to remain undisturbed until sleep occurs.

#### ACTION

When injected into the rectum tribromethyl alcohol is absorbed by the intestinal mucosa more rapidly than the water in which it is dissolved. The absorption is fairly rapid, totaling 80 per cent in the first 20 minutes, and 95 per cent within the first 2 hours. No local irritation of the rectal mucosa has been observed from the use of a properly prepared and tested solution. During anesthesia the concentration of tribromethyl alcohol in the blood is 6 to 9 milligrams per cent.

Detoxication of tribromethyl alcohol occurs in the liver through the formation of a compound with glycuronic acid; the resulting product being eliminated by the kidneys. Straub recovered 81 per cent of the drug in this combination from the urine within 48 hours, and Parsons obtained 72 per cent in the same period. Slight traces of bromine have been found in the perspiration, but not in the feces or in the expired air.

Respiration is superficial in tribromethyl alcohol anesthesia, but in cases of dyspnea,

the respiratory center is not materially affected. The heart is evidently not influenced by the average anesthetic dose. The pulse rate is practically normal, and there is usually little change in blood pressure, although occasionally a fall up to 20 millimeters occurs. (We observed 2 cases of marked fall in blood pressure without apparent shock.)

In from 3 to 10 minutes after the rectal administration of tribromethyl alcohol solution, sleep occurs without a preliminary stage of excitement. The patient retains no recollections of the induction of anesthesia. Return to consciousness is almost always uneventful, as the awakening from a natural sleep. In 7 per cent of our cases a generalized tremor was noted during induction, or before the return of consciousness. This occurred only during light anesthesia. There was no nausea or vomiting in 78 per cent of cases. Catheterization was required in 6 per cent of the series, once following hemorrhoidectomy and twice after pelvic operations. For 25 per cent of the operations (mostly minor procedures) no supplemental anesthesia was required. Patients withstood even hemorrhoidectomy and perineal operations well without supplemental anesthesia, and were remarkably free from postoperative pain.

#### ANESTHESIA

The outstanding feature which makes tribromethyl alcohol a remarkable agent is the ease with which anesthesia is produced. No anesthetic with which we are familiar approaches it in this respect. It is now possible to produce unconsciousness without the patient being aware that an anesthetic is being given. The patient falls asleep in 3 to 10 minutes without mental or physical excitation, and usually recalls the experience only vaguely and then as a pleasant one. Thus, surgery has been divorced from much of its terror. Tribromethyl alcohol is a boon to the excitable and apprehensive patient, and especially to children. It has filled a great void in pediatric surgery. A child is given the small tribromethyl alcohol enema in bed without any disturbance, and in a few minutes falls asleep without excitement and without being aware of the impending operation.

The initial stage of tribromethyl alcohol anæsthesia usually lasts from  $1\frac{1}{2}$  to 2 hours. The relaxation under tribromethyl alcohol alone is generally sufficient for all minor operations and sometimes even such major ones as amputation and hernioplasty. In abdominal work, however, we prefer supplemental anæsthesia with ethylene (or nitrous oxide) and oxygen, or with novocain, locally. The necessity of complete relaxation cannot be over-emphasized because much postoperative shock, ileus, and even infection can be ascribed to an unyielding abdomen. Furthermore, more time is consumed and more trauma inflicted when the abdomen is rigid, thus contributing to postoperative morbidity.

We have had but one failure, and that was due to improper preparation of the patient. In this case the rectum was distended with fluid when tribromethyl alcohol was administered, and the entire rectal contents were expelled. We have not found it necessary to stop the anæsthetic or to resuscitate a patient in our series. On the other hand, we have been impressed by the freedom from cyanosis (the patient being watched carefully to prevent mechanical obstruction), sweating, and marked fall in blood pressure, which are common with other anæsthetics.

#### POSTOPERATIVE STAGE

As a rule, patients leave the table dry, pink, and warm. The wet pallid skin that is occasionally seen after ether, spinal, or even local anæsthesia is entirely absent.

At the end of the initial stage of the anæsthesia the patient reacts, and may complain of pain, thirst, or hunger, upon being relieved with morphine, he falls asleep again for several hours. During this period there is no nausea, vomiting, or motor restlessness, there is less postoperative distention and less abdominal pain than after other general anæsthetics. Patients who previously had 7 or 8 anæsthetics stated that they experienced much less discomfort with tribromethyl alcohol and preferred this type of anæsthesia.

Hæmorrhage during or immediately after operation has never been a source of concern.

Not a single patient has complained of rectal irritation, nor have the nurses in at-

tendance recorded sanguineous or mucous discharge from the bowel. Two patients have had three successive tribromethyl alcohol anæsthesias within 7 to 10 days without untoward effects.

There has been no unusual delay in healing of the wounds, and the patients, generally, have left the hospital on the appointed day.

Comparative changes in avertin anæsthesia in operative cases

	No. of cases	Average change after operation
Red blood cells	20	-122,400
White blood cells	19	+6,242
Hæmoglobin	20	-1.3
Clotting time	5	No change
Blood sugar	10	+3 mg
Non protein nitrogen	9	+4.5
Chlorides	8	-5.3
Carbon dioxide	4	-8
Pulse rate	20	+5
Respiratory rate	20	+3.15
Blood pressure		
Systolic	20	+4.5
Diastolic	20	-3.4

In our series there was nothing noteworthy in the urinary findings. A trace of acetone was found in 5 cases, but only in 1 specimen from each patient. (Gwathmey reports this finding in two ether series, in 88.5 and 26 per cent respectively.)

The blood examinations were about 24 hours after the anæsthesia, while the records of the pulse and blood pressure were taken at the beginning and end of anæsthesia.

In only 22 per cent was nausea or vomiting present. This is a very much lower percentage than we have had in ether and gas anæsthesia.

The remote effects of tribromethyl alcohol, if such there are, can scarcely be intelligently discussed, as only about 7 months have elapsed since we initiated its use, but if the toxicity is serious, we should expect to find such evidence in damage to the liver or kidneys, as they are the chief organs involved in the elimination of the drug. We are not cognizant of a reliable test of liver function, but we can approximate kidney damage by the urine examination. Recent examination of the urine of some of the earliest cases failed to show any essential change in the urine.

#### CONTRA-INDICATIONS

Avertin anæsthesia is contra-indicated in (1) severe diseases of the liver and kidneys.

(tribromethyl alcohol is detoxified in the liver and it is nearly all excreted through the kidneys), (2) advanced pulmonary tuberculosis, (3) ulcerative diseases of the rectum and colon, (4) extreme cachexia, and (5) acidosis.

In dehydrated and elderly patients tribromethyl alcohol should be used with great care. It is especially well tolerated in hyperthyroidism. In the presence of hypothyroidism it has been suggested that the delayed elimination might be hastened by the administration of thyroxin.

#### AUTHORS' SERIES

We have employed tribromethyl alcohol in over 500 cases, but only the first 100 cases have been used as the basis of this report. The major operations were for the following conditions: appendicitis, 41; hernia, 14; goiter, 4; gall bladder or gall duct disease, 12; intestinal obstruction or neoplasm, 4; uterine tumor, 4; gangrene of the leg, 2. The remainder (19) were minor surgical procedures.

The dosage has been conservative, no effort having been made to complete anaesthesia with tribromethyl alcohol alone, as this was deemed unwise and not without danger. Marked cyanosis has not occurred in any case. This is attributed to the fact that we used a light dosage, the patients have been watched carefully, and a clear airway has been maintained at all times.

#### CONCLUSIONS

Anaesthesia can be induced with tribromethyl alcohol in an almost ideal manner. Convalescence is more comfortable and there is less nausea and vomiting than with other general anaesthetics. In our opinion tribromethyl alcohol has a definite place among the anaesthetic agents now available.

A review of the foreign literature leaves one confused if an effort is made to evaluate tribromethyl alcohol as a general anaesthetic. When used alone for deep anaesthesia, its use is attended with danger, but when used as a basic anaesthetic, it is probably one of the safest agents for anaesthesia. We feel that the use of tribromethyl alcohol with gas or novocain, combines in the highest degree, excellence and safety in anaesthesia.

We stress the fact that no anaesthetic is absolutely safe, and the same precautions should surround the administration of tribromethyl alcohol that attend the use of any other anaesthetic. Carelessness will be penalized by morbidity and mortality. A conscientious regard for the safety of the patient demands the services of a well trained anaesthetist in every major operation.

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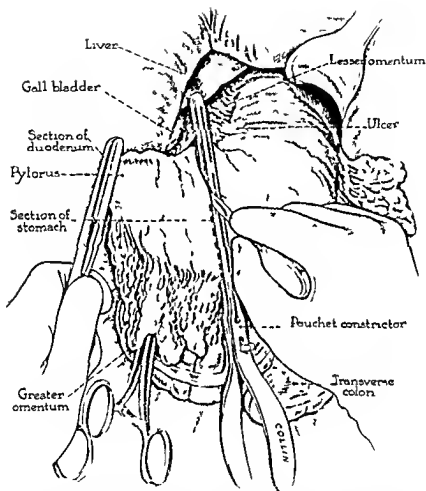


Fig. 20 The stomach is sectioned vertically from the lesser to the greater curvature below the ulcer. Here a constriction has been placed on the stomach but that is not necessary. It is sufficient to place one forceps at the top and one at the bottom of the line of section and cut from one to the other.

# CLINICAL SURGERY

FROM ST MICHEL HOSPITAL, PARIS

## SURGICAL TREATMENT OF ULCERS OF THE SUPERIOR THIRD OF THE STOMACH (GROOVE RESECTION)

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AND

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**B**Y ulcers of the superior third of the stomach we mean any ulcer between the boundary of the middle and upper thirds of the stomach and the cardia. Nineteen per cent of gastric ulcers are included in this class. Such ulcers are often perforating and are particularly frequent in men between 50 and 60 years of age. They are many times associated with ulcers lower in the stomach or in the duodenum. Because of the anatomical form of this special variety of ulcer, surgical treatment is not always easy and the most ardent advocates of resection hesitate to undertake it under such bad conditions. Resection by the usual method is difficult because of the height of the focus, and because it is not easy to establish an anastomosis beneath the diaphragm on such a small gastric stump (Fig. 1). That is why we propose a method of resection which avoids this difficulty. We have been using the technique to be described for several years and so far it has given good results.

The operation is a groove resection which fulfills the double indication of all stomach resections: (1) excision of the ulcer and adjacent parts and (2) removal of the secreting part of the stomach. In addition it leaves a gastric stump sufficiently large to prevent too great functional disturbance and by transforming the stomach into a tube it re-establishes the gastro-intestinal tract.

We would like to emphasize the value of this method. It should be used systematically and not as a last resort in cases in which the ulcer is situated high. We are using this technique more and more even in cases of ulcers which are situated in the middle third of the lesser curvature and in which the stomach is not readily movable.

### TECHNIQUE

After section of the duodenum and liberation of the stomach, the latter is divided along a line which starts from the greater curvature at the boundary between the antrum and the body and passes upward in the direction of the lesser curvature. At about the place where the upper third meets the lower two-thirds, the direction of the resection is changed so that the line of incision passes to the left side of the cardia, describing a curve which encircles the ulcer and the tissue immediately adjacent to it. The resected part of the stomach includes, as has been stated, the pylorus, the antrum pylori, and the lesser curvature of the stomach on which the ulcer is located (Figs. 2 and 3).

The operation may be done in one stage by making the entire incision at one time but it is hard to free the stomach or if the boundaries of the ulcer are not very distinct, it is easier to use two stages. In the first stage the stomach is sectioned completely along the line joining the greater and lesser curvatures, while in the second stage the curved line is sectioned (Figs. 20 and 21).

The details of the operation are as follows:

*Incision of the wall.* A median incision extending from the ensiform process to the umbilicus is used. If it is necessary, and it often will be, a branch incision may be made perpendicular and to the left, which gives very free access to the region. We do not advise chondral or costal resections which become infected easily and result in weak walls (Figs. 4 and 5).

*Exploration and liberation of the stomach.* The posterior surface of the stomach is reached either by pushing the insertion of the great omentum from the greater curvature with compresses or



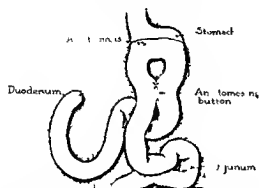
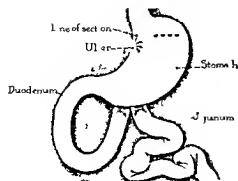


Fig 1 The operation subtotal gastrectomy with long loop anastomosis and complementary jejunojejunostomy is not to be advised because it is too hard to perform

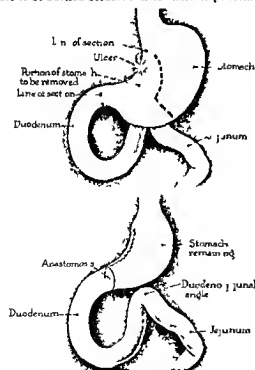


Fig 2 Groove resection of same type of ulcer completed by a Péan's anastomosis

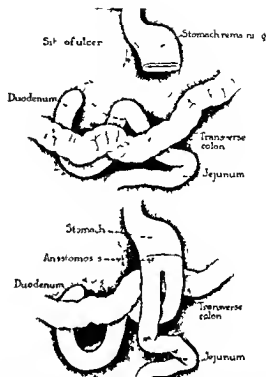


Fig 3 Operation of choice—groove gastrectomy which is completed by a precolic Iliac anastomosis with a short loop

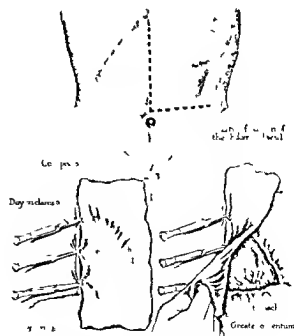


Fig 4 L incision turned to the left Fixation of the operative fields

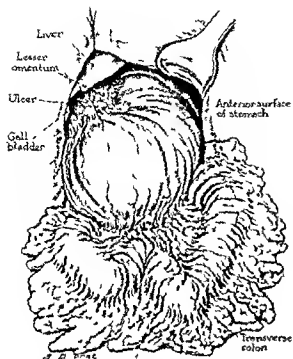


Fig 5 Exploration of the anterior surface of the stomach. The operator can see the ulcer which is situated high on the lesser curvature

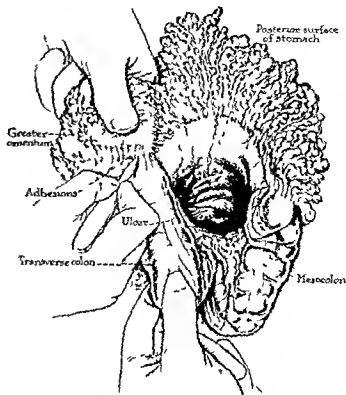


Fig 6 After detachment of the colon and omentum the ulcer can be seen on the posterior surface

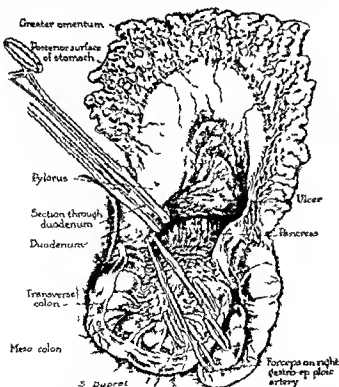


Fig 7 The liberated duodenum is sectioned between two forceps following the dotted line. Hemostasis of the pyloric artery (labeled right gastro epiploic)

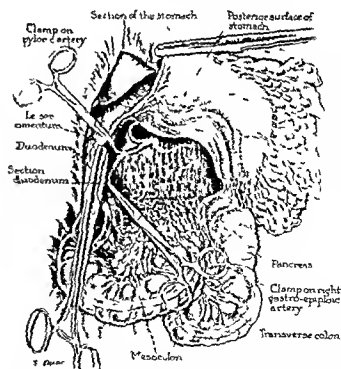


Fig 8 The duodenum has been cut and the lesser omentum sectioned. The three arteries to be ligated are right gastro epiploic, pyloric, and coronary of stomach



Fig 9



Fig 10

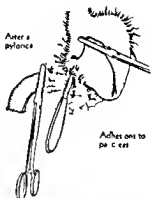


Fig 11

Fig 9 Search for the coronary artery. The left index finger is inserted between the lesser curvature and the pulsating cord of the stomach near the lesser curvature. 2 sectioned small omentum. 3 coronary artery seen through the transparent mesocolon.

Fig 10 Ligature of the coronary artery. The suture carrier gliding along the index finger perforates the lesser omentum. The thread is properly placed.

Fig 11 Dissection of the perforating ulcer at the pancreas.

by detaching the omentum from the colon by section. The latter method seems preferable to us because it is more elegant and more anatomical; it separates and sections rather than tears. Moreover, it is bloodless and does not require the many ligations that are necessary after other methods; also stumps of omentum that may become more or less infected and cause adhesions are eliminated (Fig 6).

At this stage the ulcer is examined more thoroughly, its exact situation is determined, and its

size and the extent and kind of adhesions to the adjacent planes are noted.

**Section of the duodenum.** Even in the operation of gastropyloric resection, it has always seemed to us preferable to section the duodenum first, but in cases in which the ulcer is situated high this is absolutely necessary in order to liberate and section the stomach; there is no choice. The attachments of the omentum to the upper and lower borders of the duodenum are divided with a bistoury or scissors, particularly the upper part

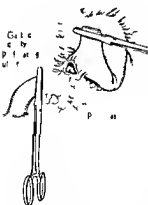


Fig 12



Fig 13

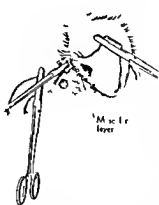


Fig 14



Fig 15

Fig 12 In the course of the dissection the stomach is opened at the site of the ulcer. This opening is unavoidable due to the fact that there is a loss of stomach substance.

Fig 13 The contents of the stomach are evacuated through the opening by means of an electrical aspirator.

The base of the ulcer can be seen on the anterior surface of the pancreas.

Fig 14 The stomach is dissected free by means of a tampon which is mounted on forceps.

Fig 15 As the adhesions become firmer scissors are taken to section them.



Fig. 16 The stomach is held by three forceps and the incision which permits of economical resection combined with removal of the ulcer, is traced on the mucous membrane of the anterior surface

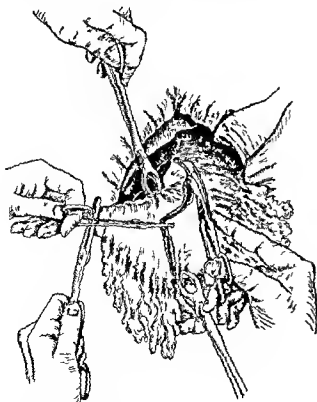


Fig. 17 The anterior surface is sectioned with scissors Chaput's forceps is placed at the angle where the incision turns

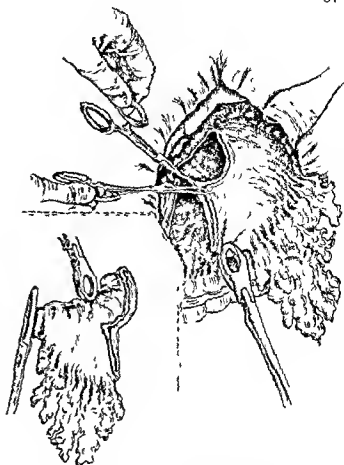


Fig. 18 Appearance of stomach when resection is completed and of the part that has been removed

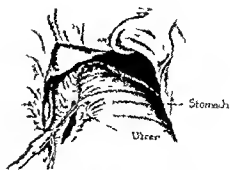
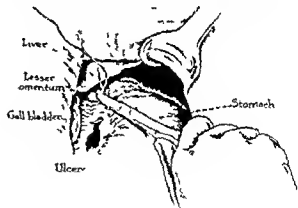


Fig. 19 How to place the mooring suture to prevent retraction of the stump of the stomach toward the cavity of the diaphragm

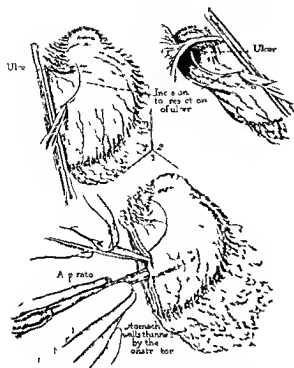


Fig 21 With a bistoury the operator traces the limits of the resection, first on the anterior and then on the posterior surface of the stomach. The excision includes the ulcer and the adjacent indurated tissue. Below necessary aspiration of the stomach contents. No clamp can be applied.

of the right border of the great omentum which is cut between two ligatures, care being used not to injure the serous covering of the intestine. The vessels that bleed are caught with forceps, particularly the pyloric artery. Then two strong forceps are placed parallel on the juxtapyloric part of the duodenum and the duodenum is cut between them. The cut surfaces are painted with iodine (Figs 7 and 8). The sectioned stump is covered with compresses and laid aside for the moment.

*Section of the lesser omentum, liberation of the lesser curvature, and ligation of the coronary artery.* If the ulcer has not perforated we proceed as follows. Along the upper border of the stomach and a little above it the gastrophrenic omentum is sectioned, the line of incision passing toward the cardia. This step generally does not cause any hæmorrhage, but if bleeding does occur the cut vessels are caught with forceps and ligated. The lesser curvature is thus liberated. If there are adhesions to the deep layers the point of a bistoury or scissors which grazes the wall of the

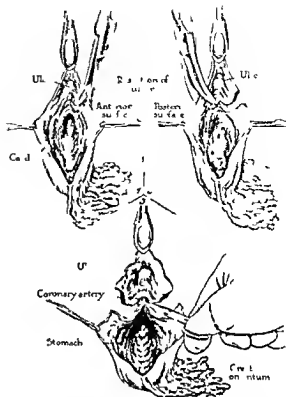


Fig 22 Excision of the ulcer of the lesser curvature under the control of vision. Thanks to the mooring suture held by an assistant there is no retraction. In 3 the coronary artery is being constricted with forceps as it has not been possible to ligate it in advance.

stomach is used. When the incision reaches above the ulcer the coronary artery is ligated. This ligature should be placed as high as possible, near the coeliac trunk. The lesser curvature is grasped between the thumb and index finger of the left hand, a few millimeters from the border of the stomach; a pulsating cord will be felt, the index finger is passed from behind forward in the little space between the two (Fig 9); a suture carrier is passed along the index finger and perforates the meso, the suture is in place and need only be tied (Fig 10). The meso is then cut between the ligature and the ulcer, the incision passing horizontally to the right border of the stomach, the meso should be completely sectioned but the serous covering of the stomach should not be incised. If this stage is properly done the hand suddenly feels the stomach "give", the lesser curvature seems to unroll as if a cord that held it up had been cut. Care must be taken not to tear the stomach by pulling on it violently as all the region around the ulcer is very friable.

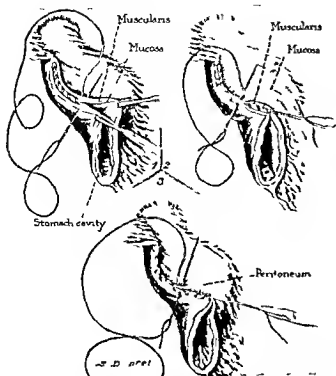


Fig 23 The remaining part of the stomach is transformed into a groove which will become a tube by reconstruction of the lesser curvature. This reconstruction is carried out in three layers as the walls of the stomach are thick. Two layers may be enough

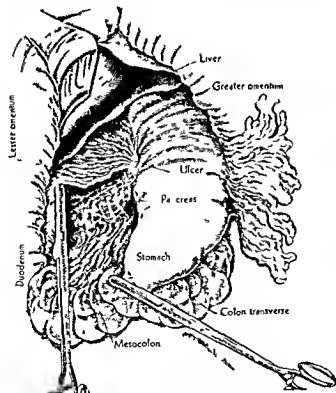


Fig 24 The stomach after section of the duodenum, is freed to the region of the ulcer. The line of gastric section which must encircle the ulcer is marked with a dotted line

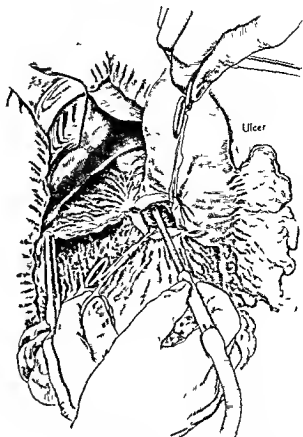


Fig 25 The dissection of the ulcer penetrating into the pancreas opens the stomach. Aspiration of the gastric contents



Fig 26 The upper boundary of the ulcer is freed with scissors. A mooring suture has been passed above it in the lesser curvature and the coronary artery has been ligated

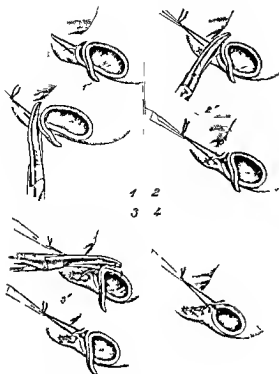


Fig 27 The removal of the ulcer is completed by excision with scissors of callous part of stomach adjacent to it. As the section is made catgut sutures are placed so as to reconstruct the lesser curvature immediately.

If the ulcer has perforated into the pancreas which is true in the majority of cases, we proceed as follows. The adhesions if any are present are freed. They are generally quite loose and unite the upper surface of the stomach with the lower surface of the liver. The stomach is held by traction on the forceps which closes it and stretched, and with short cuts of the scissors the lesser omentum is sectioned above the lesser curvature until the diseased zone is reached (Fig 11). The scissors are laid aside and with a tampon mounted on a pair of forceps, the adhesions are freed methodically to the right and left of the ulcer and below it. In this way more ground is gained than might be supposed and the perforating region of the ulcer is demarcated well. A cutting instrument is then taken—bistoury or scissors—and the adhesions that have resisted the tampon are freed. This process is outlined until the place where the stomach is adherent to the pancreas is reached. Short incisions are then made with the scissors along the surface of the gland until the stomach cavity is opened. This necessarily happens because there is loss of substance (Fig 12). The



Fig 28 The diseased stomach tissues are removed and the lesser curvature reconstructed. The operator then traces on the serous and muscle layers of the wall the posterior suture line of the body of the stomach.

tube of the electrical aspirator, which is also absolutely essential in this operation, is introduced through the opening and the stomach is emptied (Fig 13). The surgeon or his aid passes a finger under the stomach to encircle and stretch it, and the upper outline of the ulcer is liberated. The part that remains in the pancreas, as it forms a part of the latter, is painted with iodine to await attention later. After the stomach has been removed bits of stomach wall that remain may be removed with a curette or the point of a bistoury (Figs 14 and 15).

Section of the lesser omentum is finished and the coronary artery is ligated as before. Sometimes the indurated tissue around the ulcer extends up very high and the ligation of the vessels has to be put off until the following stage when the upper part of the stomach is sectioned.

If the ulcer has perforated into the liver, liberation is generally easier, the work is done in front of the organ, and the surgeon can see what he is doing.

After having freed the adhesions with a mounted tampon, the liver and stomach are separated.

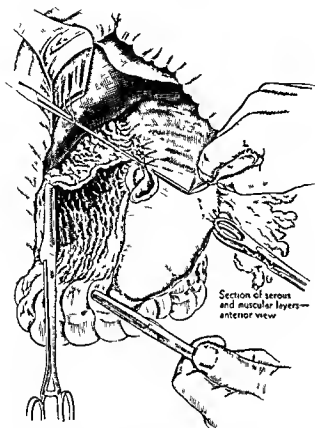


Fig. 29 The operator traces in the same way the future line of section of the anterior surface

rated with a cutting instrument. Care must be taken not to tear the liver, for this would cause regrettable hæmorrhage necessitating tamponing that would be fatal to the adjacent sutures. Here too it is better to leave a little of the ulcer adherent to the liver after having painted it with iodine.

**Section of the stomach.** As already stated the stomach may be sectioned in one or two stages.

**Section in one stage.** After the stomach is completely freed of its attachments, the surgeon chooses the place where the vertical part of the section is to be made near the junction of the antrum and the body. He puts a Lane's hook on the greater curvature at this place and a second one on the lesser curvature at a corresponding point below the ulcer. An assistant pulls these two forceps in opposite directions to stretch the stomach in width, and the operator pulls on the forceps which closes the pylorus and stretches it in length. He traces the incision on the serous membrane with the tip of a bistoury, it starts to the right of the lower forceps which should be left on the part of the stomach that is to remain, and passes up to the upper forceps, but at the junction of the lower two-thirds with the upper third it changes its direction, and passes upward

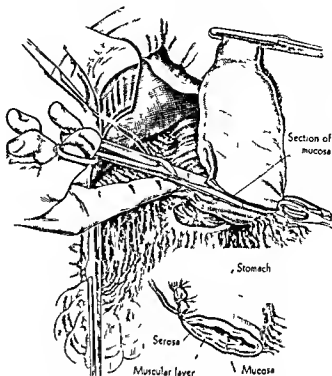


Fig. 30 Section of the body of the stomach following the tracing

and to the left to encircle the ulcerated region, it should pass distinctly outside the limits of the latter and then run obliquely to the lesser curvature above, near the point where the coronary artery has been ligated (Fig. 16).

A suture should now be placed to prevent the later rise of the stump of the stomach, so that the sutures can be placed on the lesser curvature without danger. This "mooring suture" which is of strong catgut, is passed with a curved needle very high up between the œsophagus and the upper end of the ulcer. It is not tied but a forceps is placed on it and the forceps is handed to an assistant who holds it until the reconstruction of the lesser curvature is finished (Fig. 19).

After having marked the line of section in this way, the stomach is still held stretched and the anterior wall is sectioned in the vertical part of the line and then in the curved part. As soon as this latter part of the section is started, a Chaput's forceps should be placed on the angle where the turn is made, to serve as a tractor and guide (Fig. 17). The same thing is done on the posterior surface, it is sectioned parallel to the anterior opening and a Chaput's forceps is placed at the junction of the two parts of the incision. When the section has been done in this way, the stomach is made up of two parts, floating above, united below by the greater curvature, that is, it is transformed into a veritable "groove" (Fig. 18).



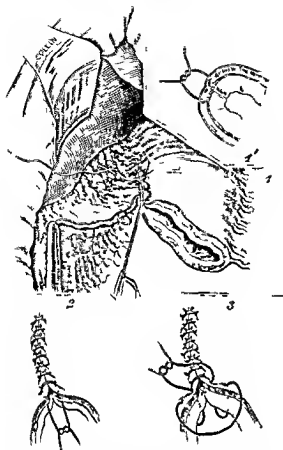


Fig 31 The suture of the lesser curvature is completed by a layer of interrupted serous sutures 2 and 3 The way in which the last sutures are placed

It is obvious that as soon as the stomach is opened at the beginning of the vertical section, the aspirator must be introduced to empty the stomach so that the operation can be continued dry

Section in two stages is advisable in very difficult cases and those in which the ulcer is very high up. The forceps are arranged as for section in one stage but throughout their width from one forceps to the other, the anterior wall is cut and then the posterior wall to the right of the forceps. This gets rid of the entire antrum of the pylorus (Fig 20). A Chaput's forceps is placed on each one of these sections at the starting point of the curved incision which is to circumscribe the ulcer. Excision is done with curved scissors. At this stage the surgeon may ligate the coronary if this has not been done before (Figs 21 and 22).

The appearance of the stomach is then the same as when the technique for the one stage

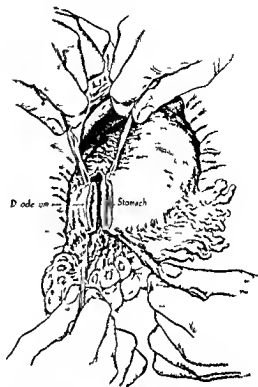


Fig 32 The stomach whose caliber is reduced to that of the duodenum is placed in contact with the latter in order to make a Pican anastomosis (Billroth I)

operation is used. These different sections may be made with the electrical bistoury, which is haemostatic and sterilizing.

*Reconstruction of the lesser curvature is generally easy enough, except perhaps high up near the cardia.* As an assistant pulls on the two Chaput forceps at the angle so as to stretch the upper edges, the operator sutures the whole tract uniting the two curved sections and continuing the sutures to the angle of the wound. Fine catgut is used and the suturing is done from above downward, from the difficult to the easy. A serous suture is now made over this total suture and the gastric groove is transformed into a tube (Fig 23).

If it is too difficult to place these continuous sutures in the high part of the incision some interrupted sutures may be used in both layers (total and serous). But in either case great care must be used, particularly in the higher part of the wound, to prevent secondary disunion.

There are cases in which a perforating ulcer is very high on a small, retracted stomach and the surgeon may fear difficulty in reconstructing the lesser curvature with small gastric flaps disappearing under the diaphragm. If the stomach is not

very large it may be desirable to make as economic a resection as possible in the ulcer region to avoid retraction which would disturb function later. In that case a third method may be used, derived from the two preceding ones, in which the order of the stages is inverted.

The operator proceeds by liberating the greater curvature, sectioning the duodenum, and liberating the lesser curvature up to the region of the ulcer (Fig. 24). He then dissects the perforating ulcer with bistoury and scissors and the stomach cavity is thus opened (Fig. 25). With the field now in full view he excises the lesion of the walls to its boundary and the corresponding part of the lesser curvature (Fig. 26). The lesser curvature is reconstructed while a solid hold can still be had on the non resected stomach (Fig. 27) and only when this reconstruction is completed is the resection terminated by doing the vertical section of the body of the stomach (Figs. 28, 29, 30, and 31).

In short, in this method the curved area encircling the ulcer is resected first and the vertical gastropyloric section is done last.

Obviously the method or combination of methods used should be selected according to the type of lesion and the choice of the operator. When the resection is finished, the stomach is decreased in width and resembles the intestine more or less in form. The remaining stages are like those in the ordinary resection.

*Re-establishment of the gastro intestinal tract.* If the duodenum is large it can be sutured end-to-end to the stomach to make a Pean anastomosis (Billroth I, Fig. 32).

If the duodenum does not lend itself to a Pean anastomosis it should be closed and a terminolateral implantation made of the stomach into the jejunum (Polya) either with a short loop or with a long transmesocolic or precolic loop. In this

case it is never necessary to decrease the cross section of the stomach, its mouth is not too large and the whole of it can be used. This is the method that we use most frequently (Fig. 2).

The stomach may be closed completely and a laterolateral gastro enterostomy performed (Billroth II). We have never tried this method.

*Closure of the wall of the abdomen.* This can be done in one or several layers, following the usual method and according to the preference of each operator.

#### RESULTS

In the beginning in ulcers of the superior third of the stomach we practiced either conservative operations or high subtotal resections.

The former gave us, in 5 cases, 1 death and 2 revisions necessitated by lack of improvement, or 20 per cent mortality and 50 per cent bad results.

The second method was used in 23 cases with 6 deaths, a mortality of 26 per cent.

In the 6 years that we have been using groove resection we have had 7 deaths in 44 cases or 15 per cent, a greatly decreased mortality—2 deaths from failure of the opening to function, 1 from pulmonary complications, 1 from peritonitis caused by the breaking down of the sutures, 3 from unknown causes in patients with multiple ulcers which, as is known, make the operative prognosis bad.

As to late results, we have been able to re-examine 22 patients treated by groove resection. In 17 of the cases the results were very good, in 4 cases good, and in 1 case mediocre. All these patients were able to resume a normal life quickly and to stop adhering to a strict diet.

In conclusion we would say that groove resection is an operation which seems to produce cures and is attended with less risk than are the so-called "conservative" operations.

# FROM THE SURGICAL CLINIC OF PROFESSOR VON HABERER THE BILLROTH I RESECTION OF THE STOMACH

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THERE are two reasons which prompt this writing. The article by Dr. V. Orator published in the September, 1928, number of *SURGERY, GYNECOLOGY AND OBSTETRICS* leaves one with an incorrect conception of the von Haberer technique and it is the wish of both Haberer and Orator that this misconception be corrected, secondly, alterations have been made in the procedure which considerably improve the operation.

It is the aim of this paper to describe the usual resection, as indicated in duodenal ulcer, omitting those phases which are peculiar to the case and which each operator must clarify for himself.

One of two anesthetics, either deep ether or splanchnic, is administered and the peritoneal cavity is opened through a midline incision from ensiform to umbilicus. Accurate hemostasis of the abdominal wall and peritoneum is insisted upon. Gauze gloves are worn over the usual rubber ones to afford better traction.

The stomach is examined and the decision for or against resection is made. Unless there is a very definite indication, e.g., duodenal, gastric, or peptic jejunal ulcer, carcinoma, or a poorly tolerated gastro-enterostomy, the gastrectomy is not performed. Palpable glands in the lesser omentum or along the greater curvature are important aids in making a diagnosis. In peptic jejunal ulcer the enlarged glands in the mesentery of the jejunal loop are of equal value in assisting the surgeon to reach a conclusion.

Before continuing with the steps of the resection, we will give a brief resume of the arterial supply to the stomach.

The celiac artery divides into three branches

left gastric, splenic, and hepatic. The left gastric rises upward to the left and enters the gastro-hepatic ligament just below the cardia. It distributes branches to the esophagus and cardia while the main vessel continues along the lesser curvature to anastomose with the right gastric artery.

From the hepatic artery, the right gastric and the gastro-duodenal arteries are derived.

The right gastric leaves the hepatic just above the pylorus and runs in the gastro-hepatic ligament to anastomose with the left gastric artery.

The gastroduodenal artery leaves the hepatic artery below the right gastric, runs posterior to the beginning of the duodenum, and lies directly on the pancreas. It divides into the pancreaticoduodenal and right gastro-epiploic arteries. The former follows the medial surface of the duodenum and the latter runs along the greater curvature where it anastomoses with the left gastro-epiploic artery.

About 3 or 4 centimeters from the spleen, the splenic artery gives off the left gastro-epiploic artery which enters the greater omentum, follows the greater curvature, and anastomoses with the right gastro-epiploic artery.

The preparation of the stomach is begun by ligating and dividing the right gastric artery close to the pylorus. The lateral wall of the duodenum is freed to about 1 centimeter below the ulcer. As a rule the gastro-hepatic ligament is divided up to and including the left gastric artery. Through the opening thus created the left hand is passed behind the stomach and firmly grasps the latter so as to place the greater curvature under tension. In a similar manner the vessels in the gastrocolic ligament are ligated and severed. Generally the preparation of the greater curvature begins with division of the left gastro-epiploic artery and is concluded by ligating and dividing the right gastro-epiploic and some branches of the pancreaticoduodenal arteries.

The posterior duodenal wall can now be studied. If necessary the pancreas is bluntly dissected away for a short distance to make certain a posterior lying ulcer does not exist. In most cases where the pancreas can easily be pushed off, the posterior ulcer is not present.

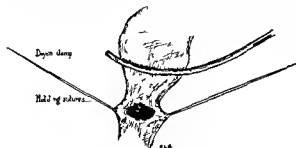


Fig. 1. Position of Doyen clamp and holding sutures.

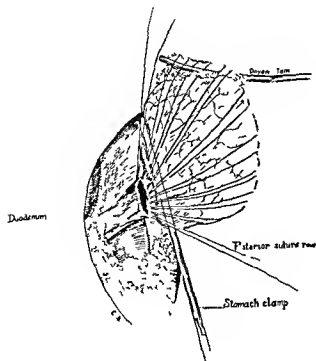


Fig 2 The posterior row of interrupted sutures in position

Holding sutures are placed on the lateral and medial sides of the duodenum immediately below the anteriorly lying ulcer (Fig 1). A Doyen clamp is fastened just proximal to the pylorus, the peritoneal cavity is protected with sponges, and the anterior duodenal wall is cut through with the cautery (Fig 1). While the holding sutures are held under tension the operator inserts a sponge into the duodenum to prevent its contents from escaping. The inner surface of the posterior wall of the duodenum is then examined under direct vision (Fig 1). When a clamp is used on the duodenum one is very likely not to see the posteriorly lying ulcer and this, in the opinion of Haberer, is the chief cause of so called recurrent duodenal ulcers after Billroth I operations. Having carefully excluded the posterior lesion, the remainder of the duodenal wall is divided with the electric cautery.

The Doyen clamp is removed, a sponge is placed over the open pylorus, and the Doyen clamp is replaced so as to secure the sponge (Fig 2). The stomach is then lifted up, drawn to the patient's left, and the Haberer clamp adjusted at the upper resection level (Fig 2) which is the point where the left gastric and right gastroepiploic arteries have been severed. The stomach and duodenum are brought into close apposition and the end-to-end anastomosis begun.

The posterior row of interrupted linen sutures is placed in the following sequence both corners

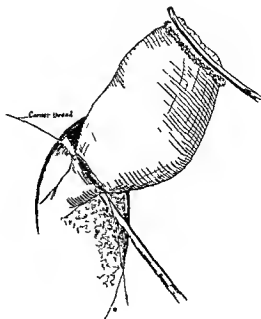


Fig 3 The two corner threads are held in clamps

to replace the holding threads, the middle, and then the intervening ones (Fig 2). The threads are tied in the same sequence in which they were laid but not until all have been placed. The two corner threads are held in clamps and the rest cut off (Fig 3).

The serosa and muscular layer of the posterior stomach wall are divided by an incision parallel to and about one half centimeter above the previously laid suture row (Fig 4). This procedure

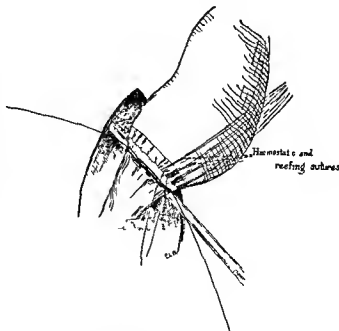


Fig 4 Division of serosa and muscular layer of the posterior stomach wall

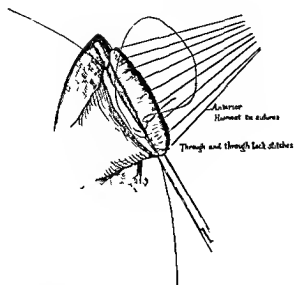


Fig 5 Through and through lock stitch secures posterior wall

clearly exposes the vessels of the stomach wall which are ligated by interrupted catgut suture ligatures (Fig 4). These stitches not only have a hæmostatic value but they also reef the stomach making its lumen approach that of the duodenum. A similar incision is made on the anterior wall and the vessels suture ligatured in a like manner. One leaves the anterior flap longer to facilitate making the anastomosis. The second Doyen is placed



Fig. 6 Operation completed

distal to these stitches the suture ligatures having been left long are put under tension, and the stomach is removed with the cautery.

The posterior row of hæmostatic sutures are cut and a through and through lock stitch further secures the posterior wall (Fig 5). Upon reaching the corner one cuts the anterior hæmostatic sutures and continues with the lock stitch until the two lumina are united. Von Haberer makes no attempt to invert the mucosa with this stitch. The anterior wall is completed by placing Lambert serosal sutures so as completely to cover the locked suture row. It is the usual procedure to lay the middle and two end sutures before removing the stomach clamp. The end result gives one an anastomosis of about two fingers capacity and the stomach rests on the duodenum 'Wie der Pilz am Stiel' (Fig 6).

The abdominal wall is united in layers

## OPERATIVE MEASURES IN THE TREATMENT OF AFFECTIONS OF THE LUMBOSACRAL AND SACRO-ILIAC ARTICULATION

WILLIS C. CAMPBELL, M.D., F.A.C.S., MEMPHIS, TENNESSEE

**C**ONSERVATIVE measures alone are indicated in a majority of cases with affections of the sacro iliac and lumbosacral articulations, but in a small percentage symptoms persist in spite of all known remedies, such as eradication of foci, physiotherapy, and various orthopedic procedures. However, affections in this region are so common that even this small percentage means that a large number of patients are not relieved, and the problem thus becomes a serious one from an industrial standpoint.

In cases in which tuberculosis is a causative agent, fusion operations have been routinely employed for the past 15 or more years, but only in recent years have these measures become commonly used in the presence of non-tuberculous affections. Since 1916, however, the author has used fusion operations not only in selected cases of non-tuberculous origin, but has gradually increased the scope of the procedure as experience has demonstrated its value.

Low-back pain is too intricate a problem to discuss briefly, except in a very superficial manner. The syndrome in non-tuberculous affections may be instigated by a variety of causative agents which may be divided into those in which the site of the disease is in the spine and pelvic articulations and in those in which the pain is referred from pathological involvement of organs not connected with the spine. The causative agents which involve the articulations are (a) infection, (b) trauma, (c) postural defects, and (d) congenital anomalies, those external to the spinal column are (a) affections of the pelvic and abdominal organs, (b) affections of the spinal cord, and (c) intestinal stasis or toxæmia.

Those second group, or those in which the pathology is external to the spine, must be excluded in making the diagnosis. We are concerned only with those in which the symptoms are due to local affections of the lumbosacral and sacro iliac articulations.

Differentiation must also be made when possible of the exact site of pathology, whether in the articular process of the lumbosacral region, the intervertebral disc, the intervertebral foramina, or in the sacro iliac articulations. There are three main articulations to consider—the sacro-iliac and the lumbosacral articulations, any two, or all three, of which may be involved. Differentiation can usually be accomplished by a careful routine

physical examination, but not in every instance, as in analogous affections of joints. The examination must be systematic and careful in order to differentiate between lumbosacral lesions and those of the sacro iliac joints. The examination should be made with the patient in three positions—standing, sitting, and lying. When the patient is standing, muscular rigidity is more pronounced and the characteristic attitude is more apparent. Motion is also restricted to a greater degree when the patient is in this position. Differentiation of involvement of the sacro iliac joint is made by the following signs. A characteristic sign noted in the examination of many patients with involvement of the sacro-iliac joint is brought out by asking the patient to bend forward. Motion up to a certain point may be free and painless but beyond this flexion causes pain and the spine deviates from the midline, usually toward the affected side. When the patient is in the sitting position tension of the hamstring muscles on the pelvis is relaxed and forward bending is somewhat freer than in the standing position. In the recumbent position passive movements of the spine may be carried out to practically the normal range. Localized points of tenderness may be demonstrated by pressure over the sacro iliac joints, the insertion of the ligaments, or over the sciatic nerve at its exit through the sciatic notch of the pelvis. With the patient on his back the affected leg is raised with the knee extended. If pain is present on this manipulation, the Kernig sign for meningitis is positive. As pointed out by Goldthwait, this sign is often present in affections of the spinal column. The exact time of the occurrence of pain is a valuable point in the differentiation of lumbosacral and sacro-iliac involvement. One hand is placed under the lumbar spine, the other flexes the hip, if pain is experienced before motion is detected in the lumbar spine, sacro iliac involvement is indicated. If the patient does not complain of pain until there is movement in the lumbar spine, the affection is in all probability in the lumbosacral joint. Compression of the iliac crest is also a valuable diagnostic sign. The patient lies on the affected side and the examiner presses downward over the opposite iliac crest, and if the sacro iliac joint is affected, pain is felt on firm pressure. A variation of this sign, though not so valuable, is direct backward pressure over the pubic bone.



Fig 1 Incision for extra articular fusion of the sacro-iliac joint exposing outer half of posterior surface of sacrum and posterior half of crest of ilium

Gaenslen has recently described a diagnostic maneuver which he believes is useful in differentiation between lumbosacral affections and between right and left sided sacro-iliac lesions. The patient, lying supine, flexes one knee and hip acutely. The patient is then brought well to the side of the table and the opposite thigh is slowly hyperextended by the examiner with gradually increased force. The hyperextension of the hip exerts a rotating force on the corresponding half of the pelvis in the sagittal plane through the transverse axis of the sacro-iliac joint. The pull is made on the ilium through the Y ligament and the muscles attached to the anterior superior and anterior inferior spines. As a result of the impaired ligamentous support on the affected side, this rotating force causes abnormal mobility accompanied by pain, either local or referred, in the region of the sacro-iliac joint on the side of the lesion. If the lumbosacral articulation is involved, this maneuver does not cause pain. In addition, in affections of the lumbosacral joint the pain is confined to that region and there may be a localized point of tenderness in the midline overlying the joint. The symptoms which are characteristic of sacro-iliac involvement are usually absent. However, none

of the signs is positively diagnostic. All of the signs are rarely present in a single case.

The roentgenogram is by no means conclusive, as there are many cases in which pathological change is present, though the roentgenographic manifestations are negative, and also there are instances of positive findings which may have no definite bearing on the existing symptoms, for instance, there may be a definite destruction or proliferation in one sacro-iliac articulation, but with all symptoms confined to the lumbosacral region. However, in a large percentage, differentiation may be made by the routine physical and roentgenographic examination. The lumbosacral region is quite analogous to the upper abdomen and bears the same relation to orthopedic surgery that the upper abdomen does to general surgery—it is a region of doubt.

An analysis of 63 cases which have been operated upon will be of material value at this time. The distribution of the local pathology in these cases is as follows:

	Cases
Infection	35
Trauma	11
Congenital anomalies	3
Benign tumors	1
Tuberculosis	13
	<hr/> 63

Tuberculosis is of course, also an infection, but as the status of this disease is such a different problem, a separate discussion and classification is made for better comprehension. Of the 13 tuberculous patients, 11 were adults, 5 males and 6 females, 2 were children. The ages ranged from 10 to 45 years.

In those in whom the etiology was other than tuberculosis, 35 were males and 15 females, ages varying from 17 to 53 years. In this group infection was by far the most frequent cause, being present in 35 of the 50 non tuberculous cases. Four cases of infectious origin gave a definite history of trauma, while in 11 of infectious origin the relation of trauma to the cause was doubtful and indefinite. In the 35 remaining cases there was not a scintilla of evidence of injury. In one with atrophic and destructive changes, there was a spondyloarthrosis, without a history of injury.

Trauma may, of course, be an instigating factor whenever there is a defect in the skeleton from any cause, but should only be considered as a primary factor when there is a definite relationship between the trauma and the onset of symptoms. There were 11 cases in this series in which we believe that trauma was undoubtedly the sole

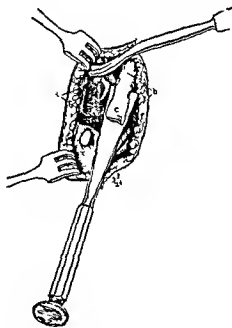


Fig. 2 Removal of a portion of crest of ilium, A, sacrum, B, ilium, C, fragment from crest of ilium

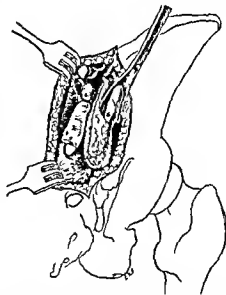


Fig. 3 Placing of multiple chips into denuded gutter formed by posterior surface of sacrum and inner surface of dorsum of ilium, A, small bone particles, B, large bone fragment

cause In 5, gross fractures could be demonstrated by the roentgenogram, and in 2 spondylolisthesis In 4 instances no pathology was apparent, but as the injury and subsequent symptoms were so severe and persistent, the diagnosis of low-grade traumatic arthritis was warranted Even in those with definite traumatic lesions the possibility of associated infections from a distant foci must always be considered, especially in those past 35 years of age Sacro-iliac dislocation or separation, though frequently diagnosed erroneously, is of rare occurrence, and can be caused only by such violent injuries as being caught between two box cars, but even then the ilium is more frequently fractured parallel with the articulation This error has often been due to the roentgenogram having been taken at such an angle that one joint has been apparently wider than its fellow on the opposite side

Congenital anomalies, as enlarged transverse processes, spina bifida occulta, sagittal articular facets, and numerical variation can be considered only as a potential weakness and when present can not be accepted unequivocally until other possible agents have been excluded But such gross defects as wedging, hemi-vertebra with gross distortions and displacements, as occurred in the 3 cases reported, can be regarded as only a definite cause

Static defects are usually associated with faulty posture and can be considered as a predisposing factor only There is always associated generalized muscular and ligamentous weakness which is manifested by flat feet, lax joints, enteroptosis, etc In no instance in our cases was this condition

considered the sole cause, though it is well recognized that lumbosacral pain may be caused by faulty posture, especially increased lordosis In this type of individuals, operative methods are rarely advisable, and we believe that treatment should be mainly general with an effort to correct body mechanism

The object of all operative procedures in affections of the lumbosacral or sacro-iliac regions is to fix or splint, by an internal osseous bridge, the affected area, which may be one, two, or all three articulations These procedures in the spine are well known and were devised by Albee and Hibbs, of New York, for the treatment of tuberculosis of the spine Each have evolved a procedure and have proved conclusively that osseous fusion may be accomplished thereby These measures have been modified in the lumbosacral region and several methods originated for the purpose of fusing the sacro-iliac joint, but only that of the author, reported in *SURGERY, GYNECOLOGY AND OBSTETRICS*, in August, 1927,<sup>1</sup> with such modifications as have been since employed, will be described in detail The procedure of the author for fusion of the sacro iliac joint has the advantage of being entirely extra-articular and of avoiding the danger of lighting up a latent infection, which is a most serious complication, especially is this true in tuberculosis of this articulation The technique of the procedure in the sacro iliac joint will be first considered and is as follows

An incision is made along the outer lip of the crest of the ilium from the posterior one-third or

<sup>1</sup>Vol. xiv, 218.



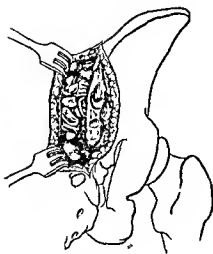


Fig. 4 Multiple grafts completely filling the denuded gutter



Fig. 5 Fusion between sacrum and ilium posterior to sacro iliac joint

one half of the posterior inferior spinous process. This is carried down to the bone where the periosteum is incised and elevated for a considerable distance and the posterior portion of the dorsum of the ilium is exposed. The crest of the ilium is dissected free to raw bone and the adjacent fibrous tissue removed from the posterior surface of the sacrum beneath the region of the erector spinæ, or sacrospinal muscle. A portion of the crest is removed and placed in a towel. The inner surface of the overhanging portion of the crest of the ilium and adjacent posterior surface of the sacrum is denuded, thus forming a raw gutter made parallel with the sacro iliac joint, formed by the posterior surface of the sacrum and the inner surface of the ilium posterior to the sacro iliac joint. Into this space is placed the graft from the crest. Multiple grafts or 'shavings' are next secured from the dorsum of the ilium and placed into the gutter until the space is well filled, when the wound is closed in layers. When desirous of also fusing the lumbosacral articulation the anterior aspect of the transverse process of the fifth lumbar vertebra may be isolated and also denuded, after which the osseous graft from the crest of the ilium is placed into the gutter, already described, but extended upward to approximate the denuded surface of the transverse process of the fifth lumbar vertebra. In those cases in which it is necessary to fuse all three articulations, the same procedure may be carried out upon both sides thus fusing both sacro iliac joints and the fifth lumbar vertebra to the sacrum. This extension to include the fifth lumbar vertebra has only been recently applied in a small number of cases, but with distinct success.

However, enough time has not elapsed to determine whether a sufficient area of the spine may be fused in this manner to relieve symptoms. After completion of the operation the patient is placed on a Bradford frame for a period of 6 weeks, when a low back brace with sacro iliac belt is applied.

In those in whom fusion of the lumbosacral spine is required in addition to fusion of the sacro iliac joint, we have also employed a curved or convex graft from the crest of the ilium, which we have transplanted into the spinous process of the lumbosacral region after the manner of Albee.

The lumbosacral region alone has also been fused by the Albee graft where the spinous processes are in the same plane but unfortunately, there is considerable lordosis in many patients. Therefore, it is often necessary to break down the spinous processes, denude the laminae, and then transplant an osteoperiosteal graft from the tibia which conforms accurately to the lumbosacral region and which is a combination of the principles evolved by Albee and Hibbs.

Of the 63 patients there were 47 in whom operative measures were applied for fusion of lumbosacral articulations. 34 of these were fusion of the lumbosacral articulation alone, and 13 were fusions of the lumbosacral articulation combined with fusion of one or both sacro-iliac joints. In 29 patients the sacro iliac articulations were fused, in 10 cases the sacro iliac joints alone were fused, and in 13 cases fusion of both lumbosacral and sacro iliac joints was performed. In 16 cases of fusion of the lumbosacral joint, the Albee method was employed, in 3 cases of fusion of the sacro iliac joints, the procedure described by Smith Petersen was

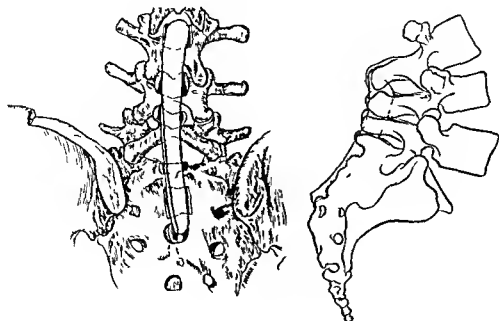


Fig 6 Fusion of lower lumbar vertebrae and sacrum, by means of a curved graft from crest of ilium

used In the remaining cases the methods devised and employed by the author, as described, were used The results of the Albee operation, as demonstrated by the roentgenogram, were excellent, but estimation as to the clinical result can not be given, as the procedure was so often combined with an operation for fusion of the sacro-iliac joint However, there was every clinical evidence that this was an excellent method by which the spine could be fused The number in which the Smith-Petersen operation was used is too small to consider The results of the operative treatment in the 63 cases may be estimated in the accompanying tables

By excellent is meant complete relief In those classed as good, symptoms persisted to some extent, but there was permanent and lasting improvement There were two deaths in attempted fusion of the lumbosacral and sacro iliac joint at one operation In both, the crests of the ilia were transplanted into spinous processes, as described Since these fatalities we do not employ this method, except in very robust individuals There was no mortality in those in which fusion of the lumbosacral and sacro iliac or bilateral fusion of sacro iliac and lumbosacral by the other methods described

In the tuberculous cases there were no operative deaths The deaths reported were the result of complications occurring some time after operation In the death following attempted fusion of the sacro iliac joint the procedure was intra-articular, and death was due to tuberculous meningitis

The roentgenogram demonstrated definite abnormality of the articulation in 54 cases In 9, no abnormality could be demonstrated which very clearly illustrates the value of the X-ray as an aid to diagnosis

Operations have been devised for fusion of all three articulations, as there is some difficulty in determining the exact location of the pathological process, and, also it has been suggested that, when one or two joints are arthrodosed, symptoms are induced in the remaining joint by undue stress, strain, or shearing action In the series reported, we have fused only those joints in which there was clinical evidence of disease, and in only two instances have symptoms occurred in adjacent joints after fusion has been accomplished Therefore, unless a higher percentage of successful results can be demonstrated by routinely fusing all three articulations, more extensive surgery is not at present indicated Of course, when there is apparent pathology in all three articulations, fusion of all is advisable, but whether this can be efficiently accomplished at one operation with safety to the patient remains to be demonstrated

In conclusion, I desire to emphasize that—

- 1 Conservative measures, when possible, should be employed before fusion operations are considered

- 2 In all cases with tuberculous involvement, fusion operations are indicated as early as possible

- 3 In those cases with persistent symptoms and definite abnormalities demonstrated by the roentgenograms, fusion operations are advisable

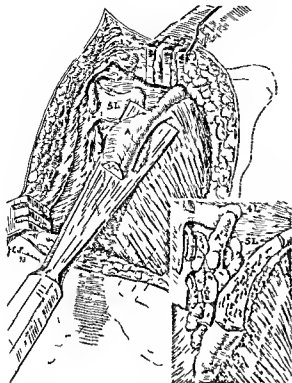


Fig 7 Removal of posterior portion of the crest of the ilium. Insert shows removed portion of ilium A lying on denuded surfaces of sacrum and transverse processes of fourth and fifth lumbar vertebrae. Multiple chips are placed about the portion of the ilium and into the denuded gutter.

4 In those cases in which the symptoms persist, even though the roentgenogram will demonstrate no pathology, fusion is indicated, but only after all extraneous causes have been carefully excluded.

5 Fusion operations are often indicated much earlier in wage earners, especially in those who do

TABLE I—NON-TUBERCULOUS

	Excellent	Good	Poor	Died	Unknown	Total
Sacro-iliac (alone)	7	0	2	0	2	11
Lumbosacral and sacro-iliac	6	1	3	2	1	13
Lumbosacral (alone)	14	4	2	0	6	26
	27	5	7	2	9	50

TABLE II—TUBERCULOUS

	Excellent	Good	Poor	Died	Unknown	Total
Sacro-iliac	2	0	2	1	0	5
Lumbosacral	6	0	0	2	0	8
	8	0	2	3	0	13

not depend upon compensation and can not give sufficient time for conservative treatment.

6 Fusion of the lumbosacral articulation causes no practical disability. Flexion of the spine may be slightly limited. Fusion of the sacro-iliac causes no disability.

7 These procedures should be carried out with precision. If unduly prolonged, shock with an increase in the percentage of fatalities is to be expected. Not over one hour should ever be consumed for operation, and in most instances, much less.

8 The operative mortality from fusion of any one articulation is practically nil, and, with sufficient care, should be exceedingly low in all procedures in this region.

9 The percentage of successful results here reported very clearly proves the value of these operative measures and that chances of permanent cure are excellent in a type of case in which permanent disability often persisted.

FRACTURES OF THE ACETABULUM<sup>1</sup>

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S.B., M.D., AND JAMES J. CALLAHAN, M.D., CHICAGO

**D**UE to the peculiar strains and severe injuries incident to automobile and aeroplane accidents, fractures in and around the acetabulum are becoming far more common. Such fractures are difficult to diagnose when considered from a clinical standpoint and only too frequently it happens that a single X-ray film fails to show the essential pathology present. For this reason stereoscopic and oblique plates should be made. In our service we have had several cases of fracture of the acetabulum, and the more we have considered them the more we are interested in the classification, the treatment, and the prognosis. We have not been entirely satisfied with the classification as presented in the various texts and articles.

As in almost every type of fracture of the acetabulum there is the possibility of serious disturbance in the function of the hip joint, more care should be used in diagnosing these cases so that treatment can be started at an early period. In our series the four serious failures are due to delay and mistreatment. In Case 2 (Pardon) and Case 3 (Cashion) treatment consisted in extension on a Hawley table and the application of casts. In the third case, Case 6 (Cheluk) no treatment was given for 2 weeks. In this case we feel reasonably sure that had we been able to institute early treatment an excellent result could have been obtained. In the fourth case, the patient, Magderez, was seen at the end of the ninth week and nothing could be done with manipulations and open operation was refused.

Some fractures, particularly those of the rim, should be operated upon at once or at least before the small fragments have been crushed, absorbed, or so misshapen by new growth that they cannot be replaced correctly. We do not consider that the method described in this paper, of using a screw in the trochanter for traction should be called radical treatment. We have found that it is very simple and we feel that it is conservative. However we are sure that many injuries occurring in this area will be treated with radical open operation and accurate replacement of the fragments when the condition is better understood. In order to stimulate systematic thinking in relation to fractures of the acetabulum, we are submitting the following classification, which no doubt, will require many corrections and frequent

rearrangements. However we trust that it will be an aid to others in clearing up the conception of the etiology and morbid anatomy of such fractures.

## CLASSIFICATION OF FRACTURES OF THE ACETABULUM

A. *Fractures of the rim*

- 1 An oblong fragment on the posterior lip of the acetabulum, essentially that portion contributed by the ischium in its development
- 2 An oblong fragment, essentially that portion contributed by the ilium
- 3 An oblong fragment, essentially that portion contributed by the pubic bone

B. *Fractures of the acetabulum involving one or two of the three bones of which it is formed*

- 1 Fracture with displacement inward and backward of the ischial segment and ramus
- 2 Fracture with displacement inward of the pubic segment and ramus
- 3 Fracture displacing both the pubic and ischial segments with ramus
- 4 Fracture with displacement inward and backward of the ilial segment

C. *Perforating fractures*

In this type the head is forced through the bottom of the acetabulum with a very small amount of the surrounding bone.

D. *A fracture so extensive that all of the bones are involved and fragmented*

## ETIOLOGY

In dealing with the etiology of these fractures it is obviously necessary to deal with those of the rim separately from those involving the deeper portions of the cup. We have one history of an individual being knocked off a wagon and landing heavily on the left foot, thus causing a fracture of the upper and posterior portion of the rim of the left acetabulum. We have one case of a man 65 years of age, who, while sitting in the right hand seat of an automobile in a head-on collision, suffered a fracture of the ilial segment of the acetabular rim. This is shown in Figure 1 (Starck). This man was unconscious, sitting upright in the seat. Obviously his right knee had been jammed against the dash and the aftercoming pelvis had caused fracture of the acetabular rim.

The fracture of the acetabulum which is characterized by a perforation or by an involvement of one of the three divisions, or by all of the divisions, can be produced only by applying a force to the trochanter major, such as occurred

<sup>1</sup>Read before the Southern Surgical Association, Atlanta, Georgia, December, 1919.



Fig 1

Fig 1 Starck. Fracture of the ilial segment of the acetabular rim. No treatment was given except rest in bed for 8 weeks. Result poor. Marked arthritis and severe crippling.

Fig 2 Pardon. Fracture through the ischial segment with dislocation inward and backward of the segment and



Fig 2



Fig 3

the ischial ramus. Treated with traction on a Hawley table and a cast. No improvement.

Fig 3 Cashon. Fracture of the ischial segment with dislocation inward and backward of the segment and the ischial ramus. Treated with traction on a Hawley table and a cast. No improvement.

one falls and lands heavily on his side. Numerous cases of this type are in the literature and, in fact, a fall is the causative factor in the great majority of the cases in the old literature. At this time the automobile, the steam or electric cars, and the aeroplane are essential factors in adding to the frequency of the lesion.

Surgeons became interested in the mechanics of the production of acetabular fractures 30 years ago. A series of experiments were made by Vireveaux of Lyons, France, in 1898, and he published a report as a thesis in 1899. In this work Vireveaux used a very heavy metal hammer to produce the force. The leg was extended and slightly abducted when the trochanter was struck with the hammer. Four acetabular fractures were thus produced, one of which was of a perforating type. The neck of the femur was broken many times. In two experiments on one cadaver the knee was struck with the sledge and the result was described as negative.

The next experimental work was done in the anatomical laboratory of Northwestern University Medical School by Charles M. Fox, working with and under the direction of Dr. William E. Schroeder. A description of this work was published in the *Quarterly bulletin of Northwestern University Medical School* in April of 1909. In the same issue Schroeder reported two new cases with a resume of each of the 46 cases that had been reported previously in the literature. These

papers are classics and should be read by every one interested in these fractures. The following is taken from Fox's article.

We took fourteen cadavers and used only a five pound hammer striking the trochanter with the leg extended and slightly adducted. Of the femurs so treated four promptly fractured the acetabulum in various directions. A fragment of the ilium, one from the ischium, and one from the pubis constitute the so called inverted Y shaped fracture and allowed the head of the femur to protrude. The other results were not so typical. The lines of fracture running into the obturator foramen into the ischiatic notch and through the ramus. Of the remaining six experiments there was one impacted fracture of the neck of the femur and two fractured trochanters and three fractured necks. In four cadavers the blow was applied to the knee resulting in four fractures of the neck of the femur. It seems to me the greatest importance is to be attached to the position of the head and neck of the femur and the blow. If the force is suddenly applied the elasticity of the pelvis will be of little or no consequence and the head will be forced through the acetabulum. Whereas a slow force will be associated with vertical ring and other fractures of the pelvis.

From this description it is apparent that these investigators were seeking the perfect Y shaped or perforating fracture and that the other types of fractures did not interest them sufficiently at this time to observe the other variations carefully or to seek the reason for them. What actually happened undoubtedly was that the adducted limb was indifferently rotated, either medially or laterally so that the slight deviation of the line of force caused the unexpected and unsought results. Their

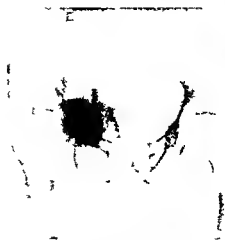


Fig 4

Fig 4 Alar fracture through the ischial segment with dislocation inward and backward of the segment and ramus

Fig 4A Alar Under traction longitudinal, with Buck's and lateral, with screw and wire attached



Fig 4A



Fig 4B

Fig 4B Alar End result, joint cavity clear cut and distinct, but a portion of the ramus and segment is still out of place Function, 80 per cent

statement that the other results were not so typical, the lines of fracture running into the obturator foramen, ischiatic notch or through the ramus bears us out in this assumption

From the cases we have studied we believe that the fractures of the various parts of the acetabulum are the result of deviations in the position of the trochanter major

In Figures 2 (Padoni), 3 (Cashion), and 4 (Alar), we have illustrations of the first division of the classification. In these there is a dislocation inward and backward of the ischial segment of the acetabulum, this segment carrying the ramus of the ischium with it and causing a fracture at the junction of the ascending ramus of the ischium with the descending ramus of the pubis

Figure 5 (Magderez) shows a fracture of the pubic segment of the acetabulum with a dislocation inward and downward of pubic ramus, which is No 2 of division B of our classification

The third division of B is shown in Figures 6 (Cheluk) and 7 (Corona) in which we see a fracture that included both ischial and pubic segments with dislocation inward of the ramus

As yet we have not encountered a fracture involving the iliac segment alone. We have no case to illustrate the true perforating type. However, in Figure 8 (Driscoll), we see a fragmentation involving all of the bones entering into the formation of the acetabulum

In making deductions as to the mechanics involved in the production of these fractures, it seems to us that the ischial fracture dislocations as shown in Figures 2, 3, and 4, are caused by the force striking the trochanter with the thigh adducted, flexed, and rotated inward

In Figure 5, the force must have been applied to the trochanter with the thigh flexed, adducted, and rotated outward. As yet we are not clear as to the position of the thigh and direction of the force necessary to produce the condition shown in illustration Figures 6 and 7 where the entire lower half of the acetabulum and both pubic and ischial rami are fractured and dislocated. This might be from the force striking the trochanter with the thigh either straight or slightly abducted. There are no reports indicating that this type of fracture has been produced by experimental work. It is our opinion that many of the more extensive fractures of the acetabulum never reach the surgical ward because death occurs rapidly from rupture of the iliac arteries and veins thus producing extensive hemorrhage

#### PATHOLOGY

With the exception of the fractures of the acetabular rim, the trauma to adjacent structures is a



Fig 5 Fracture of the pubic segment with dislocation inward and downward of the segment and pubic ramus. Seen in ninth week. Position could not be changed. Thirty per cent flexion possible. No adduction or abduction



Fig 6

Fig 6. Cheluk. Fracture of the ischial and pubic segments with dislocation inward of the segments and rami. The roentgenogram was taken at the end of the second week.



Fig 6A

Fig 6A. Cheluk. Result of longitudinal and lateral traction. Function good—about 75 per cent.



Fig 6B

Fig 6B. Cheluk. End result fair, probably caused by delay in beginning treatment.

very important factor in these injuries. In the cases collected by Schroeder and Fox, which date from the first report of Sir Astley Cooper, in 1821 up to 1909, most of the material is derived from postmortem examinations, and it is from these cases and Schroeder's operative case that we get the best idea of the extensive injury that is inflicted upon the viscera of the pelvis by fractures of the acetabulum. The iliac veins and the iliac arteries are commonly injured so that there are extensive hemorrhages that are frequently fatal. These hemorrhages in some instances extend up to and surround the kidney, and they may also extend into the anterior wall of the abdomen beyond the midline, peritonically. Blood is always found down and around the rectum and in the perineum and scrotum. Consequently, when a patient with a peculiar abdominal lesion is observed following severe trauma, the pelvis must be very carefully examined.

The obturator femoral, and sciatic nerves are not uncommonly involved, both by lacerations and by pressure. The rectum and small bowels were perforated in different cases. The bladder was frequently injured by spicules which transfix it, and great extravasations of urine were common.

If these individuals recover from their injury without a reduction of the dislocations, the head becomes firmly walled in with a mass of bone that will block out about one third of the pelvic area. In one case of this type the patient bore a child following the accident and the parietal bone of the child was grooved as the head passed the obstructing femoral head. Sometimes, when the head protrudes into this cavity, the attempts at reduction are blocked by the locking of the fragments around the head in such a manner that only

open operation will free the fragments and allow the head to be pushed back into a normal position. Once in position the head must be held by traction, both lateral and longitudinal, during the wound closure and traction must be continued for 6 weeks.

#### SYMPTOMS

The symptoms of fractures of the rim and the more extensive fractures of the acetabulum must be taken up separately.

In rim fractures, pain on motion and loss of function are always present. Tenderness around the outer surface of the joint can be elicited in thin or moderately large individuals, and we believe that as a rule the tenderness will be over the fractured segment of the rim. A subluxation will be present in a certain number of rim fractures, and, conversely, a segment of the rim can be torn off with a luxation.

If the ischial portion of the rim is fractured and the patient is in a recumbent position, the limbs will be of the same length. Flexion of the limb and medial rotation of the femur will give a peculiar click and jump. The femur then tends to remain flexed and adducted, but can be easily restored to the original position. If this condition goes undiagnosed and untreated, serious disability will result, due to repeated subluxations which are painful. Later a chronic, traumatic arthritis will develop with more or less destruction of the joint tissues.

If the ilial segment of the rim is fractured, a slight adduction is sometimes necessary to make it click. If the pubic segment is injured it can be put into a position of subluxation for diagnosis only by extension and outward rotation.

In fractures of the acetabulum which are perforating or fragmented, three very different groups



Fig 7 left Corona Fracture of the ischial and pubic segments with dislocation inward of segments and ramus. We do not believe the direction of this screw is to be as satisfactory as that shown in Figures 4A and 8A

Fig 7A Corona Result of longitudinal and lateral traction. Excellent function in the hip joint

of symptoms are present (1) those in relation to the limb and its function, (2) those in relation to the abdomen, and (3) those in relation to the genito-urinary tract and rectum

The length of the limb varies, sometimes it shows a marked shortening, at other times it is of the same length and in 3 of our cases it was from  $\frac{1}{4}$  to 1 inch longer. The trochanter is less prominent and is sometimes below Nélaton's line. The limb may be straight on the table with the foot up, there may be a little inversion if the femoral head has passed back through the ischial portion, or there may be eversion of the leg and foot if the femoral head has been driven forward through the pubic segment. Any motion, active or passive, is painful, but flexion is usually possible. Abduction is seldom possible. Adduction is possible but limited. Rotation varies with the extent of the fragmentation and the amount of displacement, but it is usually absent. Tenderness around the outer posterior surface of the joint is always present, due to the fact that pressure must necessarily be made upon the head of the trochanter in order to force the head through the pelvis. Extensive bruises over the trochanter major are common.

Marked tenderness over the lower abdomen is nearly always present and particularly severe on the side of the injury. Rigidity is common. Nausea and vomiting are not uncommon, without in-

jury to the viscera, and are due to the mass of blood and fragments irritating the parietal peritoneum. Fatal intra-abdominal hemorrhages from the iliac vessels have been noted many times in the literature.

Blood in the urine, due to ureteral, bladder, and urethral injuries, is common, although one must not forget the possibility that the kidney has been ruptured by the injury which caused the acetabular fracture. Tenderness over some portion of the pubic and ischial ramus is always present. By rectal or vaginal palpation marked tenderness can be elicited and, commonly, a mass will be found where the fracture is located, whether there has been a dislocation inward of the fragments or only a hemorrhage from the fractured bone.

#### PROGNOSIS

Prognosis varies with the extent of the injuries to the large blood vessels and the hollow viscera. Many die after a few hours from shock and loss of blood and quite a few from undiagnosed injuries of the intestines. In our opinion, in order to locate an uncontrolled hemorrhage or a perforated viscus, exploratory operation is indicated, if there is any doubt as to the diagnosis. If coroners' physicians would make postmortem examinations upon all of the so-called deaths from internal injuries, they would quickly demonstrate that this injury is a very common cause of death.





Fig. 8

Fig. 8 Driscoll. The roentgenogram shows fragmentation of the three bones forming the acetabulum with inward displacement.



Fig. 8A

Fig. 8A Driscoll. Longitudinal extension with Buck's and lateral with screw in the trochanter.



Fig. 8B

Fig. 8B Driscoll. Function of hip joint perfect.

Owing to this lack of postmortem control however the mortality has been very low. We have not encountered any of these cases in operating for acute abdominal conditions the result of trauma, and the 7 cases that have reached the fracture ward have recovered. In none of these has there been lesions of the vessels that caused any disturbance of the peripheral circulation. The viscera and genito urinary organs have not been involved in a single case. There has been one case with pressure upon the obturator nerve, but, in spite of this brief record, we are certain that we will soon encounter a group of these cases with serious complications, such as traumatic aneurism, thrombosed veins, lacerated nerves, and perforated bowels.

#### TREATMENT

Treatment obviously must first meet the emergencies as they are presented, from repairing blood vessels and perforated viscera to any of the simpler lesions.

The rim fractures should, in our opinion, be operated upon early. The fragment should be restored to as near normal position as possible and should be held in place by suitable means. If such fractures are seen late, some plastic measures should be taken to restore the acetabulum, although some surgeons advise ankylosing the hip for this condition.

In the group characterized by perforation or fragmentation, the attempts at reduction should

be made as soon as possible after injury. An anæsthetic that will give complete relaxation should be used. Whether it will be necessary to use spinal anæsthesia because of the presence of fractured ribs and pulmonary injuries, which are commonly associated with these fractures, is a question to be determined by the surgeon. A central dislocation of the femoral head is always held in central dislocation by the tone of the great thigh and buttock muscles. In order to relieve this, we have found that flexing the thigh on the abdomen, adducting gently across the abdomen, rotating the femur inward, and exerting traction with a somewhat lateral outthrust of the femur will reduce the dislocation. The limb is then straightened gently upon the table. In some cases, the head immediately slips back into the dislocated position, but in others it will remain in a relatively normal position. The head will remain in relatively normal position in cases in which a large upper surface of the acetabular cup remains but it will not remain in the reduced position if only a thin rim of the upper edge of the acetabulum is present as shown in Figure 6 (Cheluk).

There is little difference in the motions used to reduce these so called central dislocations but one must be very sure of the morbid anatomy present before undertaking any strenuous movements for fear of doing more harm.

In a true perforation, the head is sometimes locked. In such cases an incision parallel with

and above Poupart's ligament should be made, the tissues pushed away, and the restraining fragments unlocked from the neck and head. The head can then be forced out and held out by traction while the fragments are replaced and the wound closed (see article by Schroeder).

We believe that all of these cases need both longitudinal and lateral traction. Longitudinal traction is obtained with Buck's extension and a Thomas splint for support of the limb. Lateral traction is obtained by means of an incision made just below the trochanter major parallel with the long axis of the limb, a hole being drilled through the upper end of the firm cortex, through which a 4 inch wood screw is placed, preferably in the direction of the neck. The head of this screw protrudes through the wound and copper wire is wrapped firmly around the protruding head (Figures 4A and 8A). To the wire is attached a 15 pound weight which extends laterally over a horse or arm extending from the bed. Twenty pounds of weight are used at first for the longitudinal pull, the weight is later reduced to 10 pounds.

Another method of exerting lateral pull on the femoral head is by means of weights attached to a Steinmann pin which is inserted through the trochanter from before backward. This procedure naturally results in severe trauma to the tissues, and we believe that like traction with a Steinmann nail or a tongs it will be a frequent cause of pain and discomfort. For heavy lateral traction for a short interval during reduction, Cotton's method of using a strap around the inner side of the thigh is a very excellent one, but it cannot possibly exert a pull in the desired line as accurately as will a screw which is placed in the trochanter major and which extends up through the neck, furthermore if the strap is held in place for a long time it will interfere with the circulation of the limb.

The weights may be lessened after a few days, but a good substantial pull should be maintained for at least 6 weeks and no weight should be borne on the limb for 4 to 6 months. We do not believe that a walking caliper is indicated because the walking caliper will press upon the ischium and serve only to dislocate the ischium upward, as a matter of fact, it would defeat our efforts. The patient should be made to use crutches with a minimum of weight upon the extremity for 4 months and then gradually increase the weight carrying as the limb becomes stronger.

The end-results of this longitudinal extension with the adhesive plaster after the method of Buck and the screw in the trochanter are shown in illustration Figure 4B (Alar), Figure 6A (Cheluk), Figure 7A (Corona), and Figure 8B (Driscoll). Corona and Driscoll have nearly perfect hip joints. Alar and Cheluk could be classed as about 50 per cent satisfactory. In Figure 4B, in spite of traction there is a portion of the ramus of the ischium still in a position of displacement. We are not able to account for the clear-cut, apparently perfect acetabulum, and this displaced fragment. We are not sure as to just what factors are the most effective in drawing these fragments back into place, but in all probability it depends entirely upon the capsule of the hip joint remaining in contact with the fragments.

In conclusion, we wish to emphasize that we believe that by a careful analysis of each case and the necessary slight change in the direction of the skeletal traction these fairly good results may be very much improved. We have used the ordinary screw wrapped with wire around the head, but Dr Edwin W. Ryerson has suggested that we use a screw with a hook or ring at the end. With a ringed screw it would not be necessary to use a screw-driver to insert it and there would be less danger of the attached weight slipping off.

## ELIMINATION OF PAIN IN OBLITERATIVE VASCULAR DISEASE OF THE LOWER EXTREMITY

### A TECHNIQUE FOR ALCOHOL INJECTION OF THE SENSORY NERVES OF THE LOWER LEG

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**D**URING the past few years, there has been a general trend toward conservatism in the treatment of obliterative vascular lesions of the extremities. It has been the usual experience of those most familiar with this group of cases, that major amputations are frequently necessary on account of uncontrollable pain. Pain may be temporarily relieved by numerous procedures, designed and advocated to stimulate the peripheral circulation such as ligation of peripheral arteries (9) and veins (11, 12), periarterial sympathectomy (2, 8), periarterial injection of alcohol (7, 10), dorsal and lumbar sympathetic ganglionectomy (1, 5), and the use of foreign protein (3 and 5). In spite of these aids, it has often been necessary to amputate the painful leg to preserve the patient's morale and to prevent him from becoming a morphine addict.

It is our intention to show that it is rarely necessary to amputate an extremity because of pain, and furthermore that extremities which hitherto have been undoubtedly doomed to amputation because of indolent, sensitive, painful ulcerations, can often be saved if the pain factor is eliminated for a sufficient length of time to give conservative procedures a chance to take effect. It should never be necessary to amputate an extremity unless it is hopelessly gangrenous or unless intervening sepsis threatens the life of the patient.

Attempts have been made in the past to block the sensory nerves to the foot. Quenu cut the digital nerves by making small lateral incisions at the base of the toes. Corlette (6) recommended cutting the terminal sensory nerves by a transverse subcutaneous incision just above the painful ulcer. Silbert (13) reported 4 cases of blocking the posterior tibial nerve with alcohol at the internal malleolus (in one the foot became gangrenous, in another the wound healed slowly, but pain in the toes was relieved in all). However, any operative procedure below the ankle is in the zone of impoverished circulation. Therefore, the incision is liable to heal poorly and injection of alcohol into the tissues is quite likely to cause extensive sloughs.

As far as we know no one has tried to work out a systematic method of blocking all the sensory

nerves to the lower leg and foot and of exposing them high enough in the calf to give a good chance of primary union to the wound edges.

The anatomical arrangement of the nerves in the leg is very favorable for sensory block, whereas in the arm, the important nerves lie close together and give off important motor branches throughout their entire length. In the leg the trunks are widely separated, many are purely sensory, and the mixed nerves give off no important muscular branches in the inferior two-thirds of the lower leg. If desired, a complete anesthesia of the lower half of the leg and foot can be produced with no loss of motor function except in the small intrinsic muscles of the foot. These are relatively so unimportant that in 5 cases in which they have been temporarily sacrificed, the patient has subsequently walked without a detectable limp.

#### TYPES OF CASES SUITABLE FOR NERVE BLOCKING

To date we have operated upon 11 patients. Table I shows the types of cases treated, the nerves injected, and the end results. With rare exceptions, the operative incisions healed by first intention. These cases showed no important muscular paralyses. All were relieved of their pain, although in Cases 4 and 8, there was an extension of the gangrene into an unblocked painful area. After the sensory nerves were blocked, no further morphine or other drugs was necessary for the relief of pain and the patients were able to sleep soundly without sedatives. Furthermore, thorough Dakinization of the previously hypersensitive ulcerated areas could be carried out and it was possible to cut away infected toe nails and bits of necrotic fascia and tendon without any discomfort to the patient.

#### SURGICAL ANATOMY OF SENSORY NERVES IN THE LEG

We have found that even in cases of definite gangrene of the toes, small operative incisions made under local anesthesia heal well as low as the junction of the middle and lower thirds of the leg. In the presence of ulceration as high as the mid calf, it is still possible to desensitize the entire area without producing important muscular

TABLE I—TYPES OF CASES AND RESULTS

Case	Age	Disease	Local condition	Nerves blocked	Healing of operative incision	End result
1	30	Thrombo-angitis obliterans	Great toe amputated for gangrene. Sepsis and severe pain in stump	Posterior tibial	First intention	Slow but painless healing of disarticulated toe in 2 months
2	36	Thrombo-angitis obliterans	Ulceration of tip of great toe	Cutaneous branch peroneal posterior tibial	First intention	Terminal phalanx and nail avulsed without pain. Toe painless but not healed at 1 month
3	36	Thrombo-angitis obliterans	Gangrenous 2nd and 3rd toes with infection of plantar fascia	Cutaneous branch of peroneal anterior and posterior tibial	First intention	Amputation of gangrenous toes with drainage of plantar fascia healed in 2 months
4	43	Monckeberg's sclerosis	Beginning gangrene of first three toes	Cutaneous branch of peroneal and posterior tibial	First intention	Gangrene and pain spread to anterior tibial nerve. Griffith Stokes amputation
5	70	Atherosclerotic gangrene	Threatened gangrene foot with severe pain first three toes	Cutaneous branch of peroneal anterior and posterior tibial	First intention	Painless gangrene of foot in 10 days. Griffith Stokes amputation
6	70	Arteriosclerotic gangrene	Non healing ulcer lateral lower third of leg	Peroneal anastomotic and external saphenous branches of sural nerve	Delayed healing	Ulcer healed slowly and painlessly
7	67	Arteriosclerotic gangrene	Ulcer 5th toe with septic point	Posterior tibial and cutaneous peroneal	Slight sepsis	Relief of pain stump toe healing slowly
8	70	Arteriosclerotic gangrene	Painful gangrene great toe	Peroneal tibial nerve	First intention	Relief of pain gangrene advanced slowly forcing amputation
9	62	Arteriosclerotic gangrene	Painful gangrene 5th toe	Posterior tibial and cutaneous peroneal		Rapid spread of gangrene amputation
10	43	Thrombo-angitis obliterans	Painful ulcer great toe	Posterior and anterior tibials cutaneous peroneal	Slight sepsis	Complete relief of pain. Final amputation as ulcer did not heal
11	37	Thrombo-angitis obliterans	Painful ulcers dorsum of foot and great toe	Posterior tibial cutaneous peroneal sural	First intention small skin sough	Pain relieved. Ulcers grafted

palsies. Of course it is of the utmost importance to use the most rigid aseptic technique to guard against trauma of the skin edges and deep tissues, and not to spill any alcohol in the surrounding structures. In performing the injections, we have freed up each nerve sufficiently to pass a gauze compress saturated in normal salt solution beneath it and have then injected enough 95 per cent alcohol through a fine needle to distend the sheath over a length of 2 to 3 centimeters (about 3 cubic centimeters of alcohol in the case of the posterior tibial, 1 to 2 cubic centimeters in the smaller nerves).<sup>1</sup> Then we have flooded the incision with normal salt solution, approximated the deep fascia with interrupted No. 6 chromic catgut sutures and the skin with fine silk.

Figures 1 and 2 show the sensory nerve supply of the leg. A study of these plates shows that a group of two or three nerves must usually be blocked to give an extensive anæsthesia, but in some cases two can be exposed through a single

2 inch incision. It is important to inject them high enough to include all collateral branches which may leave the main trunk higher up and come down independently into the painful zone. On the other hand, it is necessary to block the mixed nerves low enough to prevent paralysis of the important muscles in the calf.

The following procedures have been found to carry out these fundamental requisites:

1. *Posterior tibial nerve.* This nerve supplies sensation to the entire sole of the foot extending over onto dorsum of toes to include distal half of the nails (Fig. 9, B). Figure 3 shows the general relations of the nerve in the leg and its important muscular branches. It is to be noted that the last muscular filament, the inferior nerve to the flexor hallucis longus muscle, leaves the trunk at the junction of the lower and middle thirds of the leg, i. e., 6 inches above the ankle. It is best to inject the nerve just below this point, but even if this inferior branch were cut, the flexor muscle of the great toe would not be paralyzed as it is supplied with a large superior branch which comes off 5 inches higher up.

The incision is made 5 inches above the internal malleolus parallel to the posterior angle of the tibia (Fig. 9, B). When the deep fascia is cut

<sup>1</sup>During the period in which this article has been in press we have seen two small trophic ulcers develop from anæsthesia lasting over 6 months. In order to avoid this we are now injecting much smaller amounts of alcohol than those recommended above—not over 1.5 cubic centimeters for the injection of the posterior tibial nerve and 1 cubic centimeter for the anterior tibial. A simple crushing of the other small nerves by a hemostat has given a satisfactory anæsthesia for 3 months. It is most desirable that regeneration should take place in from 3 to 6 months in order to avoid neurotrophic complications.

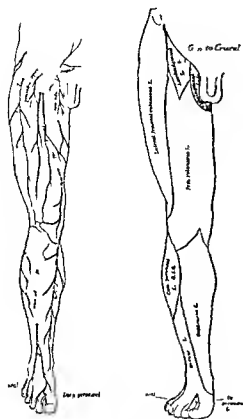


Fig 1 Cutaneous nerves of the lower extremity Front view From Gray's Anatomy Lea & Febiger 1918

through, the cleavage plane between the flexor digitorum longus and soleus gastrocnemius muscles is entered (Fig 4). With blunt dissection and adequate retraction, the neurovascular bundle is easily exposed (in a leg of average size it lies about  $1\frac{1}{2}$  inches beneath the skin). The nerve normally is the deepest of the three structures but anatomical variations are frequent. In cases of Buerger's disease, the nerve may be fused to the artery and vein in a solid mass. Extremely gentle blunt dissection must then be employed to separate the structures in the mass as the diseased vessels are friable and easily torn. An injury to the artery may easily turn the scale against a foot which is already balancing on the verge of extensive gangrene. Even if the artery appears to be completely thrombosed and pulseless, it can transmit a considerable volume of blood and must not be injured. When the nerve has been identified, it is freed up over the full length of the incision. It is then injected with 95 per cent alcohol by the method outlined above, and the incision is closed without drainage.

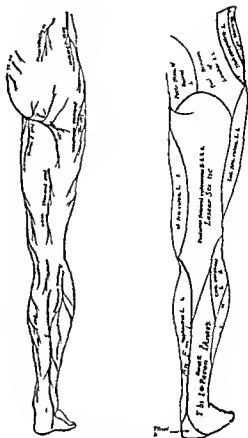


Fig 2 Cutaneous nerves of the lower extremity Posterior view From Gray's Anatomy

All of the small muscles of the sole of the foot are paralyzed for a period of 2 to 3 months, but if the patient wears some form of soft arch supporter this temporary paralysis is almost unnoticeable.

• **Deep peroneal nerve** Block of this nerve produces anaesthesia limited to the contiguous sides of the great and second toe with a small area between the heads of the first two metatarsals (Fig 5).

As in the case of the posterior tibial nerve, no important motor branches are given off in the lower third of the leg. Incision should be made 5 inches above the ankle and midway between the tibia and fibula. As shown in Figure 4, the neurovascular bundle is exposed by opening the cleavage plane between the anterior tibial and extensor digitorum longus muscles. The same precautions must be used in separating the nerve from the vascular sheath and injecting it with alcohol without traumatizing the tissues.

3 **Terminal cutaneous trunk of superficial peroneal nerve** Block of this nerve produces ant-

thesia of entire dorsal surface of ankle and foot with exception of area at the junction of great and second toes (deep peroneal nerve) and lateral side of foot and little toe (sural nerve) (Figs 5 and 6)

The superficial peroneal nerve penetrates the deep fascia over the crest of the fibula 6 inches above the ankle. It is purely sensory from this level down. To secure anaesthesia of the dorsal half of the foot with the first and second toes, the deep peroneal nerve must be blocked as well as the cutaneous branch of the peroneal. Both nerves can be exposed through the incision described for the deep peroneal, whereas if the terminal peroneal alone is to be blocked, the incision is more conveniently made three-quarter inch medial to the crest of the fibula (Fig 10, A). The nerve is found at this level either just above or just beneath the deep fascia (Fig 4). As seen in Figure 6, the nerve divides into a medial and lateral cutaneous branch. Care must be taken that the nerve is blocked above its point of division or that both branches are injected, if complete anaesthesia over its area of distribution is desired.

4 *Deep and superficial peroneal nerves* In case it is deemed advisable to block both the deep and superficial peroneal nerves, a very satisfactory exposure is obtained by making a 2-inch incision just below and medial to the head of the fibula. At this level, the common peroneal nerve will be found dividing into its two branches in the substance of the extensor digitorum longus muscle. The fibers of this muscle may be split and the sensory branches of the two nerves isolated by local stimulation, injected with novocain, the area of anaesthesia in the foot tested by peripheral stimulation and alcohol injected in the usual manner, care being used to see that before this step is taken, no muscular paralysis has resulted from the novocain injection. All of the important muscular branches of these two nerves are usually given off above a level of 2 inches below the head of the fibula. It is frequently of assistance to expose the superficial peroneal nerve as previously described at the midleg before both nerves are exposed below the head of the fibula. The sensory branch of the superficial peroneal nerve may then be more easily isolated from its muscular branches.

5 *Sural nerve* Block of the sural nerve results in anaesthesia over the posterolateral quadrant of leg and lateral portion of foot to fifth toe (Figs 2 and 7).

The sural nerve is made up of the external saphenous branch of the posterior tibial and the

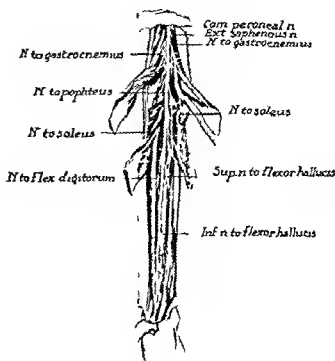


Fig. 3. Dissection of the lower leg to show the course and motor distribution of the posterior tibial nerve. Note that the inferior branch to the flexor hallucis longus is the only motor nerve given off below the midleg. From Havelock's *Anatomie des nerfs crâniens et rachidiens et du système grand sympathique*. Gaston Doin et Cie, Paris, 1927.

peroneal anastomotic nerves. These unite in the midleg to form the single sural trunk, which runs down beneath the lateral malleolus to the little toe.

If anaesthesia of the lateral portion of the foot alone is desired, the nerve may be picked up at a point 6 inches above the ankle where it lies on the deep fascia just lateral to the midline and close to the external saphenous vein (Fig 5).

If anaesthesia of the posterolateral quadrant of the leg is sought, the two branches must be blocked separately just below the knee. This can be done through the incision shown in Figure 7.

These two nerves may be exposed by a transverse incision 2 to 3 inches below the knee (carried from the edge of the fibula to the midline on the posterior aspect of the leg) or by separate vertical incisions. From our experience with delayed healing in Case 6, we feel that vertical rather than transverse incisions give a better chance of primary union. The position of the nerves is well shown in Figure 8. The external saphenous branch from the posterior tibial is easy to pick up as it lies close to the corresponding vein. Often a terminal branch of the posterior





Fig. 5 Photograph of leg in Case 5. Posterior tibial nerve exposed and injected through the medial incision; anterior tibial and cutaneous portion of peroneal nerve through the lateral incision. Anterior tibial anesthesia shown by stippled area. The lateral division of the peroneal nerve was not injected and therefore the dorsal surfaces of the fourth and fifth toes are not desensitized.

local dressings could be performed with complete immunity from pain and the sluggish neurotic tissues began to show signs of active healing within a few days.

The wound was practically healed and he was walking in 6 weeks. At present, 3 months after operation, the nerves are regenerated (with the exception of the distal 2 inches of the posterior tibial) and the patient is back at work.

**CASE 4.** J. B., aged 43 years, native, had Monksberg's sclerosis. In 1918 his right great toe was amputated for gangrene. In 1927 the foot became involved and a Gritti Stokes amputation was done. In September, 1928, he began to notice intermittent claudication of the left leg. He entered the hospital on December 5 with gangrenous ulcers at the tips of the first three toes. The foot was dusky red and the pain so severe that he asked for amputation at once, but it was decided to make a final attempt to save his remaining leg and the painful toes were desensitized by blocking the posterior tibial and cutaneous peroneal nerves. It was noticed at operation that the posterior tibial artery was thrombosed and that there was practically no collateral circulation. As the gangrene involved only the tips of the toes, the anterior tibial nerve was not injected. This was a mistake, as the gangrene slowly spread down the great toe. Within 10 days he began to complain of pain at the base of his great toe and amputation of the leg became unavoidable.

**CASE 5.** M. H., aged 70 years, Jewish, had arterio-sclerotic gangrene. Generalized arteriosclerosis with dusky redness and burning pain was present in first three toes of his right foot. The painful area in the foot was desensitized by alcohol injection of both tibial nerves and the cutaneous branch of the peroneal. It was obvious at operation that the blood supply to the foot was almost completely shut off. The pain was entirely relieved, but 2 weeks later the

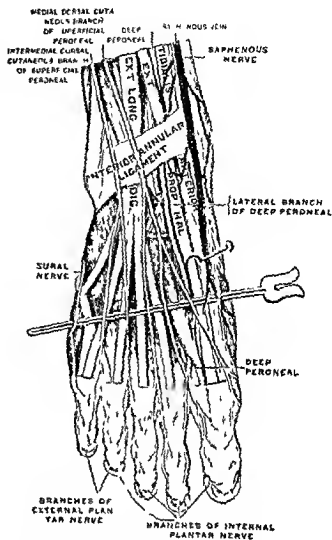


Fig. 6 Nerves of the dorsum of the foot. From Gray's Anatomy, 1918 edition, Lea and Febiger.

foot was definitely becoming gangrenous and had to be removed by a Gritti Stokes amputation.

**CASE 6.** M. S., aged 70 years, Jewish, had arteriosclerotic gangrene. This patient had general arteriosclerosis and an ulcerated area an inch in diameter on the posterior lateral quadrant of the lower leg (Fig. 7). No amount of local treatment or Burger's exercises would induce the ulcer to heal and it became so painful that the old man was reduced to a condition of chronic invalidism. The pain was relieved by picking up the medial and lateral trunks of the sural nerve and cutting them below the knee. As permanent anesthesia was necessary, 2 centimeters of each nerve were excised instead of the usual injection with alcohol. The incision became slightly septic and healed by second intention. At the end of 2 months it was healed and the ulcer itself was 50 per cent smaller. At the end of 3 months the ulcer had healed.

**CASE 7.** M. S., aged 67 years, Jewish, had arteriosclerotic gangrene. This was the case of another old man with a deep, painful ulcer of the outer surface of the little toe. X-ray picture showed marked calcification of the arteries and osteomyelitis of the metatarsophalangeal joint. No pulsation could be made out in the vessels of either foot, but the popliteal arteries were patent. To relieve his pain





Fig. 7 To show transverse incision used to expose the two trunks which make up the sural nerve with the resultant anesthesia of the lateral aspect of the leg and foot Case 6

the posterior tibial and cutaneous branches of the peroneal nerve were exposed and injected with alcohol. The toe was then disarticulated and the open stump Dakinized. Pain was completely relieved sensation however in the most proximal and lateral part of the incision remained as this region is supplied by the sural nerve. The patient was then able to tolerate thorough Dakinization and the wound was slowly healing when he was discharged from the hospital.

CASE 8 E M aged 72 years native had arteriosclerotic gangrene. One month previously this man had undergone a Gritti Stokes amputation of his left leg. When he began to walk a septic blister formed on the inferior lateral aspect of his right big toe. The dead skin was cut away revealing a necrotic base which was acutely painful. Following the procedure recommended by Sampson Handley and McCutcheon 95 per cent alcohol was injected beneath the adventitia of the femoral artery in the mid thigh. This produced no improvement in the circulation of the foot and he proceeded to develop a new ulcer on the lateral aspect of his heel. The periarthral injection did give a partial relief of pain for 5 days but it then recurred with full severity and we were forced to intervene again either by blocking the pain or amputating his remaining leg. The pain in the toe was desensitized by alcohol injection of the posterior tibial and the terminal sensory trunk of the peroneal nerve. This anesthetized the toe and the sole of the foot all but a small zone on the inferior lateral aspect of the heel where the second ulcer was situated. This could have been desensitized by blocking the sural nerve but as a third ulcer was appearing on the knee the leg was finally amputated through the lower thigh.

CASE 9 W G aged 62 years had arteriosclerotic gangrene. The patient had been suffering from the pains of intermittent claudication for 2 years. Three weeks before admission he developed a painful ulcer on the outer surface of his little toe from which burning pain radiated through the dorsum of his foot. No arteries were palpable below the main femoral in the groin.

After warning the patient that there was only the smallest hope of saving his foot the pain was relieved by

blocking the posterior tibial and the superficial peroneal nerves at the midleg (2 inches higher than the usual level on account of the extremely poor circulation). No bleeding points were encountered. Within 10 hours it was noticed that the gangrenous patch on the fifth toe was extending and on the next morning the distal half of the foot was quite definitely gangrenous. A Gritti Stokes amputation was performed. Dissection of the leg showed the popliteal and anterior tibial arteries to be completely occluded by old organized thrombi. The posterior tibial artery was like a pipe stem but open below the point of operation. Even after dissection of the leg it is difficult to account for the rapid spread of gangrene nevertheless this complication must be put down against our operative interference.

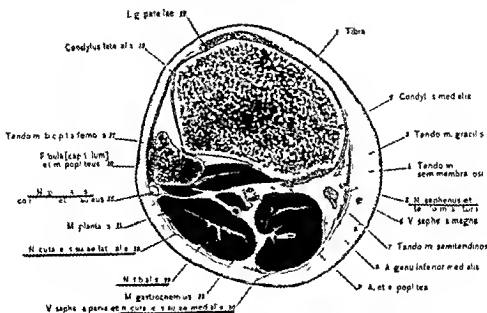
This is the only instance in our series where the procedure seems to have caused a sudden increase of gangrene. Perhaps it was bad judgment to attempt anything short of primary amputation in a leg with such a markedly impaired circulation but in any event the amputation healed by first intention and the patient's hospital stay was only prolonged five days for the attempt.

CASE 10 W P W, aged 43 years native, had thromboangitis obliterans. Two years ago the patient had his left leg amputated because of uncontrollable pain in two small patches of superficial gangrene on his first and third toes. Four months ago he returned to our clinic with his remaining foot cold cyanotic and beginning to ulcerate on the outer surface of the great toe. In spite of exercises and injections of foreign protein to increase circulation the ulcer became steadily larger and more painful. Through injection of the posterior and anterior tibial nerves as well as the terminal sensory trunk of the peroneal<sup>1</sup> the pain was completely relieved. A month later the foot remained entirely free from pain but quite unable to increase its collateral circulation enough to heal the ulcer. We were, therefore, forced into doing a Gritti Stokes amputation. This is the first instance in which amputation has as yet been necessary in the cases of thromboangitis obliterans after the pain factor has been eliminated. Dissection of the leg showed almost complete obliteration of the main vessels from the knee down and a very poorly developed collateral circulation.

CASE 11 L S aged 37 years Jewish had thromboangitis obliterans. The first symptoms of the disease appeared 10 years ago with recurring ulcerations over the past 6 years. Three years ago he was forced to stop work on account of pain. During all this period he has been treated by men experienced in the disease with exercises, injections of Ringer's solution and foreign protein. None gave relief. A few months ago he fell into the hands of a "faith healer" who applied leeches. A leech formed an ulcer and the ulcers coalesced into a single large one on the dorsum of his foot. The end of the big toe became gangrenous at the same time so that he entered the hospital in intense pain and prepared for immediate amputation (Fig. 10A). The ulcers were extremely dirty as only a thick greasy ointment could be tolerated.

In this case we were forced to block the sural as well as the posterior tibial and peroneal nerves. There was an extraordinarily rich collateral circulation in the subcutaneous tissue but the posterior tibial artery and vein were completely obliterated in a mass of scar tissue which was densely bound to the nerve. As we felt that the anterior

<sup>1</sup>In the first attempt to desensitize the dorsum of the foot a well defined nerve trunk was exposed in the usual position of the superficial peroneal nerve in the lower third of the leg. Following its injection anesthesia extended only over the proximal half of the foot. Complete anesthesia was produced by a second lateral incision exposing the nerve over the upper end of the fibula and injecting its trunk just beneath the point of origin of its main motor branches.



18. S Cross section at level of incision in Figure 7 to show position of lateral and medial sural trunks. From Ljckeslymer and Shoemaker's *Cross Section Anatomy*. D. Appleton Co., 1911.

tibial nerve would be equally difficult to expose and that too much surgery should not be done at one time, this nerve was not blocked.

As a result of these injections, the dorsum and sole of the foot became completely anesthetic (Fig. 10A and B). Only a small area deep in the first toe, where the distal phalanx was removed, remained sensitive (supplied by the un.injected anterior tibial nerve). The ulcers cleaned up rapidly under Dakin's regimen and were covered with "small deep grafts" (Davis) 3 weeks after the sensory nerves were blocked. Apparently one of the large, subcutaneous arterioles cut in exposing the sural nerve was an "end artery," as an area of discoloration appeared in the outer edge of the sural nerve incision and formed a slough 2 by 4 centimeters. The other two incisions healed by first intention. A month later the anterior tibial nerve was also blocked, as pain persisted deep in the big toe when he began to walk. He now (7 week later) has no sharp pain but tingling and prickling sensations persist when he hangs the foot down. This is probably caused by the blood distending the arterioles in the foot and must be referred over the peripheral sympathetic nerves, as the foot is otherwise completely anesthetic.<sup>1</sup>

All the patients in this series were on the verge of amputation, primarily because of pain, secondarily on account of advancing gangrene or infection. As a last hope, nerve injections with alcohol were performed to allow the patients to sleep and thereby improve their general condition and to prevent them from becoming morphine addicts. From the viewpoint of local treatment, anesthesia of the painful area permitted adequate debridement and the free cutting away of necrotic tissue.

<sup>1</sup>These sensations disappeared completely after he began to walk.

In five instances the gangrene continued to extend and amputation became inevitable, but these were extreme cases with complete occlusion of the main vessels and almost no collateral circulation. In one such case, operation seems to have precipitated a sudden thrombosis with widespread gangrene of the foot. Dissection of this leg after amputation showed no apparent operative cause for this sudden increase in gangrene (Case 9).

In reviewing the entire series on the bases of patency of the main vessels in the lower leg (Table II), it at once becomes apparent that 5 out of 7 cases with obliteration of the popliteal arteries have gone on to eventual amputation, whereas in all the ones in which this vessel could be felt pulsating the leg has been saved. Hereafter, when confronted with a painful threatened gangrene of the toes plus a thrombosed popliteal artery, we shall warn the patient that the ultimate chance of saving his leg is extremely small.

In the 5-year period preceding the institution of this method of treatment, there have been 24 amputations in cases of thromboangiitis obliterans. The records of 12 of these cases indicate that pain was either the chief cause for amputation or indirectly probably a cause in that the extremity was too painful to permit adequate conservative treatment. Five of the unamputated cases were discharged without relief of pain. Since the beginning of this work,<sup>2</sup> 14 cases have been under

<sup>2</sup>These statistics were looked up for us in the Massachusetts General Hospital records from May 30 1923 to November 13 1928 by Dr. A. Graybiel.

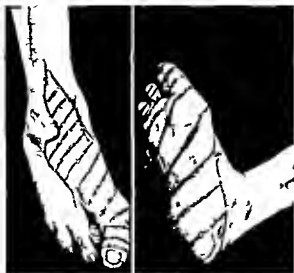


FIG 9 A Anesthesia produced by alcohol injection of anterior tibial and medial cutaneous branch of peroneal B Incision for blocking posterior tibial nerve and resultant skin anesthesia Note that there is a narrow strip along the lateral edge of the sole and heel which is not desensitized This is supplied by the sural nerve Case 3



FIG 10 Anterior view of leg showing incision for injection of both branches of cutaneous peroneal nerve the ulcer on the dorsum of the foot and the big toe disarticulated at its interphalangeal joint After the anterior tibial nerve was blocked at the second operation anesthesia was complete below the black line B Posterior view showing incisions for blocking posterior tibial and sural nerves Ischemic necrosis of skin lateral to sural incision Below the black line the leg and foot are completely anesthetic as all the nerves have been blocked except the saphenous This nerve was presumably cut across in making the posterior tibial incision Case 11

treatment 5 have required operative relief of pain, and only 1 has been amputated

In the arteriosclerotic group the results are not nearly as favorable—in the 6 which have required sensory nerve injection for pain, only 2 have avoided amputation

This is undoubtedly due to the fact that they do not develop as efficient a system of collateral circulation and that the disease more frequently obliterates the vessels above the knee

We feel that the legs in 6 out of this series of 11 patients were quite definitely saved through desensitization and rendering the septic gangrenous areas susceptible to intensive local treatment Six of these patients are now walking about with no sign of impaired function of the feet or any tendency to trophic lesions In Case 3 nerve regeneration was nearly complete at the end of 3 months, whereas in Case 1 at the end of 5 months the entire sole of the foot was still anesthetic

It may seem surprising that the operative incisions healed by first intention in the great majority of cases even when the foot ultimately went on to gangrene and amputation We believe, however, that healing of small vertical incisions can ordinarily be counted on, as in cases of the most advanced arterial obliteration, the skin temperature usually becomes normal at the junction of the middle and lower thirds of the leg

We recommend that pain be relieved early in the treatment of these cases Other conservative

procedures are much more effective in the absence of pain

It is impossible for a patient to do adequate postural exercises in the presence of intolerable pain, and we consider this an important adjunct to the treatment of such cases The same applies to externally applied heat such as an electrically heated cradle Sepsis is often an important factor One cannot control sepsis when the patient cannot tolerate Dakin's solution and frequent dressings Operations on peripheral vessels and the sympathetic nervous system designed to stimulate the circulation may relieve pain as shown by Leriche and Archibald, in many instances, however, the relief from pain is insufficient or of short duration

In closing we wish to emphasize again that most patients with painful ischemia of the feet are entitled to this ultimate conservative procedure, especially if they have already lost a leg (Cases 4, 8, and 10) It involves little risk and only a slight, very justifiable, delay if unsuccessful

#### CONCLUSIONS

1 Pain in the lower legs and feet secondary to obliterative vascular disease can be relieved by alcohol injection of peripheral nerves

TABLE II—PATENCY OF ARTERIES

Case No	Arteries			Pain after operation	Amputation of leg	Disease
	Popliteal	Dorsalis pedis	Post tibial			
1	o	o	o	o	o	Thrombo angustis obliterans
2	o	o	o	o	o	Thrombo angustis obliterans
3	+	o	o	o	o	Thrombo angustis obliterans
10	+	o	o	o	o	Thrombo angustis obliterans
11	o	o	o	o	+	Thrombo angustis obliterans
4	o	o	o	o (*)	+	Monckeberg sclerosis
5	o	o	o	o	+	Arteriosclerosis
6	+	o	o	o	+	Arteriosclerosis
7	+	o	o	o	+	Arteriosclerosis
8	o	o	o	o (†)	+	Arteriosclerosis
9	o	o	o	o	+	Arteriosclerosis

\*Subsequent extension of painful gangrene into an unblocked area

†Relief of pain complete except in unblocked area on outer side of heel

2 This can be accomplished without paralysis of any important muscles of the leg or foot

3 Careful operative technique and scrupulous asepsis are essential to success

4 A serious slough may be precipitated by spilling alcohol into the tissues

5 Incisions should be made above the lower third of the leg and should be vertical by preference. They usually heal by first intention

6 Depending on the length of nerve trunk injected, the anaesthesia produced may last but a few months or may be permanent

7 The relief of pain has been responsible for the saving of 6 out of 11 legs otherwise doomed to amputation

8 It should never be necessary to sacrifice a leg because of pain

9 After an extremity has been desensitized by this method we have noticed frequently that the foot becomes drier, warmer, and that previous color changes are eliminated. The surface temperature may rise 5 degrees F. This is probably due to elimination of sympathetic stimulation both by relieving pain and by interrupting the course of the nerve fibers to their peripheral destinations. The majority of the sympathetic nerves course peripherally with the sensory nerves

10 The result is much more apt to be successful if the popliteal artery pulsates. In cases of senile arteriosclerosis with arterial obliteration above the popliteal vessel, this procedure, even if done in two or three stages, may precipitate actual gangrene and hasten amputation. We feel, however, that, in such a case if amputation is necessary anyway because of pain, one is justified in desensitizing the extremity first

11 After an extremity has been desensitized ulcerations which previously resisted all methods of treatment will frequently heal

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INTRAVENOUS UROGRAPHY<sup>1</sup>

HERMAN L. KATTSCHNER, M.D., F.A.C.S., Chicago  
From The Presbyterian Hospital of Chicago

**T**HROUGH the kindness of Professor von Lichtenberg of Berlin, it has been my good fortune to use uroselectan in a series of 85 cases. My experience with this drug, after administering it to adults of both sexes and to children, bear out the claims made for it that it is non-toxic and non-irritating. In our series of cases, the injections were without local reactions and without local pain except in one or two instances they were also without systemic reactions such as chills and fever. Some of the patients complained of a feeling of thirst and a sense of warmth which occasionally was associated with a flushed condition of the face and head, but these symptoms were transitory and disappeared very rapidly.

In a series of 10 cases in infants and children the tolerance for uroselectan was particularly good. In these patients also systemic reactions were lacking; hence it is evident that, as a diagnostic aid, uroselectan is of great importance prior to cystoscopy in children. In 4 of these 10 cases excellent urograms were obtained after the injection of uroselectan. In one case two injections were given and no urogram was obtained. Death occurred 21 days after the second injection. This death was in no way associated with the injection, for at autopsy the kidneys were found to be the seat of very extensive destructive disease which explained their failure to eliminate the drug. The blood chemistry before injection was non-protein nitrogen, 84; uric acid, 8.6; creatinin 2.0.

Congenital anomalies were easily demonstrated by means of uroselectan injection. In our series bifid pelvis were readily shown in several instances, as was also a horseshoe kidney in one case. In the case of a solitary kidney with a stone in the pelvis on one side, no shadow was obtained on the opposite side, and cystoscopic examination and chromocystoscopy failed to show the presence of a left ureter. The diagnosis of solitary kidney in this instance was verified by operation and the stone was removed.

In one case of polycystic disease of the kidneys, the intravenous pyelograms, while readable, were not as clear cut as were the pyelograms made with ureteral catheters from below.

The best—that is the most easily readable—pyelograms and ureterograms, obtained in the regular routine, were in cases of hydronephroses and hydro ureters. In cases of unilateral involvement, it was found that the side affected stood out in marked contrast to the normal side.

In the presence of renal and ureteral calculi, the intensity of the shadow was sometimes increased by the drug. In ureteral stone, the use of uroselectan readily demonstrated whether the stone had caused a complete obstruction—a point of great value as an aid in determining whether the patient should be operated upon at once or whether, because the urine passes by the stone, delay is justifiable until the stone has progressed downward, aided or unaided by cystoscopic manipulations. In such cases the renal shadow on the affected side is much more clearly outlined than on the normal side, just as though the uroselectan had reached the kidney but that it was not being eliminated. Failure to show the outlines of the ureters when there was fluid in the pelvis of the kidney and in the bladder was due to the absence of obstruction and normal, or possibly hyperactive, ureteral peristalsis.

Because of the rapid elimination of the drug and its collection in the bladder, it is advisable to drain the bladder with a catheter in those cases in which study is directed toward the lower end of the ureter. The rapid disappearance of dilatation of the ureter following the passage of stones and also following dilatation of strictures can be satisfactorily shown by means of the drug.

Great care must be exercised in some of the very early lesions of tuberculosis and tumor. In renal tuberculosis uroselectan has given satisfactory results particularly in the group of cases in which, for various reasons, ureteral catheterization is impossible. Likewise it is a relatively simple means of investigating the remaining kidney inasmuch as pyelograms are available without catheterization of the ureter of this remaining kidney.

In malignant tumors of the kidney filling defects have been shown and a diagnosis of kidney tumor made. If great destruction of kidney tissue by the tumor has occurred the intravenous pyelograms are not so clearly defined as in pyelograms made from below. At times it is advisable to check with a retrograde pyelogram.

<sup>1</sup>Placed at my disposal through the courtesy of the Schering Corporation of New York.



Fig. 1 Normal pyelograms. Intravenous pyelograms were made to determine the origin of pain in the right upper quadrant.

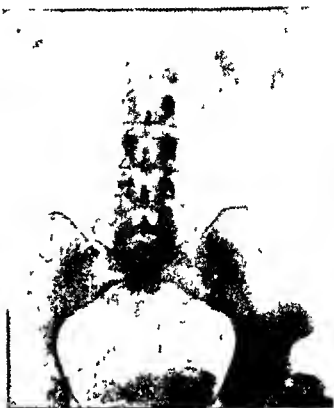


Fig. 2 Intravenous pyelograms were made to determine the origin of a large movable tumor in the right upper quadrant. Pyelograms normal. The tumor was due to an enlarged gall bladder.



Fig. 3 Congenital solitary kidney with stone. Complete absence of shadows on the left side.



Fig. 4 Showing a moderate hydronephrosis on the right side and rotation of the kidney on the left side.

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In one case of polycystic disease of the kidneys, the intravenous pyelograms, while readable, were not as clear cut as were the pyelograms made with ureteral catheters from below.

The best—that is the most easily readable—pyelograms and ureterograms, obtained in the regular routine, were in cases of hydronephroses and hydro ureters. In cases of unilateral involvement, it was found that the side affected stood out in marked contrast to the normal side.

In the presence of renal and ureteral calculi, the intensity of the shadow was sometimes increased by the drug. In ureteral stone the use of uroselectan readily demonstrated whether the stone had caused a complete obstruction—a point of great value as an aid in determining whether the patient should be operated upon at once or whether, because the urine passes by the stone, delay is justifiable until the stone has progressed downward, aided or unaided by cystoscopic manipulations. In such cases the renal shadow on the affected side is much more clearly outlined than on the normal side, just as though the uroselectan had reached the kidney but that it was not being eliminated. Failure to show the outlines of the ureters when there was fluid in the pelvis of the kidney and in the bladder was due to the absence of obstruction and normal, or possibly hyperactive, ureteral peristalsis.

Because of the rapid elimination of the drug and its collection in the bladder, it is advisable to drain the bladder with a catheter in those cases in which study is directed toward the lower end of the ureter. The rapid disappearance of dilatation of the ureter following the passage of stones and also following dilatation of strictures can be satisfactorily shown by means of the drug.

Great care must be exercised in some of the very early lesions of tuberculosis and tumor. In renal tuberculosis uroselectan has given satisfactory results particularly in the group of cases in which, for various reasons, ureteral catheterization is impossible. Likewise it is a relatively simple means of investigating the remaining kidney inasmuch as pyelograms are available without catheterization of the ureter of this remaining kidney.

In malignant tumors of the kidney filling defects have been shown and a diagnosis of kidney tumor made. If great destruction of kidney tissue by the tumor has occurred the intravenous pyelograms are not so clearly defined as in pyelograms made from below. At times it is advisable to check with a retrograde pyelogram.

<sup>1</sup>Placed at my disposal through the courtesy of the Schering Corporation of New York.

<sup>2</sup>Submitted for publication July 7, 1935.



Fig. 1 Normal pyelograms. Intravenous pyelograms were made to determine the origin of pain in the right upper quadrant.



Fig. 2 Intravenous pyelograms were made to determine the origin of a large movable tumor in the right upper quadrant. Pyelograms normal. The tumor was due to an enlarged gall bladder.



Fig. 3 Congenital solitary kidney with stone. Complete absence of shadows on the left side.



Fig. 4 Showing a moderate hydronephrosis on the right side and rotation of the kidney on the left side.



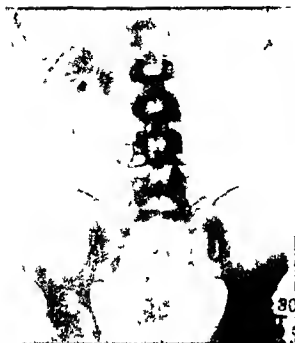


Fig 5 Bilateral hydro ureters and hydronephroses are clearly shown



Fig 7 Bilateral dilatation of ureters which is due to the presence of ureteral calculi



Fig 6 Moderate dilatation of right ureter kidney pelvis and calyces due to stone in the pelvic ureter. Left kidney normal



Fig 8 Obstruction in right ureter due to stone in the lumbar ureter with dilatation of the ureter and kidney pelvis. Left pyelogram normal



Fig 9 Stone in right ureter. Note absence of fluid in right kidney pelvis and right ureter, due to unilateral suppression. Left pyelogram, normal. Shadow of kidney has been intensified by the drug.



Fig 10 Tumor (hypernephroma) of left kidney showing collection of fluid at lower margin of kidney and calcification just below the last rib. Pyelogram on the opposite side normal.



Fig 11 Tumor of the left kidney. Right pyelogram and right ureter normal. Only a faint trace of fluid in the left kidney. Compare with Figure 12.



Fig 12 Tumor of the left kidney. Pyelograms made from below. Compare with Figure 11; note the difference. This shows the pelvis compressed, elongated and displaced.



Fig. 13 Failure to obtain left pyelogram due to destruction of kidney by tuberculosis. Evidence of involvement of opposite ureter and kidney.



Fig. 14 Intravenous pyelography. Normal pyelograms. Cystogram shows a filling defect due to a carcinoma of the bladder.

Problems of interpretation will naturally arise just as with any other new diagnostic procedure. Nevertheless, with our present knowledge of interpretation based on the reading of pyelograms made from below, in addition to the fact that doubtful cases can be checked with pyelograms made in this way, and with increasing experience gained in reading urograms made with uroselectan, the problems involved in correctly interpreting the "picture" will necessarily become less and less until finally, in my opinion, they will be negligible.

This method may serve as a check on retrograde pyelograms. In one instance a diagnosis of complete obstruction was made, based on the fact that the catheter was arrested at the brim of the pelvis and a pyelogram could not be obtained from below. An intravenous pyelogram made the next day revealed a normal pyelo ureterogram.

I have also used this new drug as a medium for making pyelograms from below, diluting the

standard solution (as used for intravenous injection) with equal parts of water. The advantages of making pyelograms with this drug from below are that the pictures are beautifully clear cut, the drug is non irritating, and there results practically no reaction from its use.

In determining the origin and location of obscure abdominal pain and in differentiating lesions of right upper quadrant and spleen, this new diagnostic procedure has been of great help.

Finally, it should be emphasized that even though the desired data have been accumulated from the standpoint of the pyelograms, it is still necessary, before surgical procedures are carried out on the kidney, to examine the patients with the cystoscope, to catheterize the ureters to carry out the usual careful examinations to determine the presence of pus and blood, to make bacteriological studies for infection—making stains for tubercle bacilli and guinea pig tests and to ascertain the differential function of the kidneys.

INTRAVENOUS UROGRAPHY IN THE DIAGNOSIS OF UROLOGICAL DISEASES IN CHILDHOOD<sup>1</sup>

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THE study of urological diseases in childhood, which has received considerable attention in the past 5 years, will no doubt gain added impetus through the introduction of the new intravenous pyelographic medium, uroselectan, recently introduced by Swick. This method of examination will prove an even greater boon in its application to children than it offers to adult urology, and will add considerably to our diagnostic accuracy. Here we have a means of visualizing the urinary organs and at the same time obtaining information as to the function and dynamics of the tract without resorting to instrumentation. Uroselectan may be used at all ages and requires no anæsthetic, thus obviating one of the disadvantages of retrograde pyelography in children. Roentgenograms taken under anæsthesia are often blurred, and the kidneys are incompletely distended as it is then impossible to judge the proper amount of solution to inject in order to fill the pelvis. All of these disadvantages have been overcome by intravenous pyelography, which, in a series of 22 cases ranging in age from 6 months to 12 years, has been found to be absolutely non-toxic.

A few words as to the historical development of intravenous pyelography. In 1923, Osborne, Sutherland and Scholl, and Rowntree first attempted visualization of the urinary tract with iodides administered both orally and intravenously. Their results did not warrant its adoption as a routine clinical measure. Since then various contributions have been made by Rosenstein, von Lichtenberg, Volkmann, Lenarduzzi, Pecco, Hryntscha, and Ziegler and Kochler. Roseno<sup>2</sup>, in 1929, obtained practical results associated, however, with some reactions, reporting excellent visualization of the urinary tract by means of a solution combining sodium iodide and urea. Finally Swick,<sup>3</sup> a few months later, introduced the preparation known as uroselectan. In a subsequent paper by von Lichtenberg and Swick,<sup>4</sup> the clinical application of this drug was described in detail.

The work on uroselectan was begun by Swick with selectan neutral, both being synthesized by

Professor Binz and Dr. Raeth on the medical service of Professor Lichwitz in Altona, Germany. The original preparation caused some untoward symptoms, and was modified to obviate some of its toxicity. The final preparation (that now called "uroselectan") we have used on the service of Dr. Beer at Mount Sinai Hospital, in collaboration with Dr. Swick, in more than 100 cases, both adults and children, without ever having noted any unpleasant manifestations after its administration.

Uroselectan is an iodine pyridin combination with an iodine content of 42 per cent. It is absolutely non-toxic, neutral in reaction, readily soluble in water, and its tolerance is exceedingly great. As a result, intravenous urography has been placed on a practical, every day working basis. Since visualization with uroselectan depends upon the functional activity of the kidney, we have in this method a roentgenological functional test, in addition to a way of gaining information as to the dynamics of the urinary tract. Aside from outlining the pelvis, ureters, and bladder, the kidney shadow itself is intensified so that it stands out in relief. Lack of visualization may mean either a non-functionating kidney, temporary inhibition, or absence of the organ. The functional value of intravenous urography can also be determined by the estimation of the substance excreted in the urine. Under normal conditions, 95 per cent should be excreted within 6 to 8 hours. About three-fifths of the substance is excreted during the first 2 hours, one quarter during the next hour, and the remainder in another 4 hours. In the case of diseased or damaged kidneys, the rate of excretion is proportionately decreased, and the substance has been found in the urine as late as 6 or 8 days after injection when stasis has been present. The specific gravity of the urine in normal kidneys is greatly increased, often reaching as high as 1040 or 1045 within a few hours after injection, whereas such is not the case in the presence of diseased organs. Studies made on the determination of the iodine component in the blood and the substance excretion in the urine, will be reported fully by Dr. Swick, together with comparative estimations of the usual functional tests (phenolsulphonephthalein, indigo carmine, concentration, and blood chemistry).

<sup>2</sup>Roseno Klin Wchnschr 1929 June 18<sup>3</sup>Swick Klin Wchnschr 1929 Nov 5<sup>4</sup>Von Lichtenberg and Swick, Klin Wchnschr 1929 Nov 5



Fig 1 Intravenous pyelogram in a girl 7 years of age. Pyelitis. No demonstrable pyelographic changes.

The technique of administration is very simple, and has already been described.<sup>1</sup> A child of 7 years of age receives one half the adult dose (which is 40 grams), and a patient of 2 years, one quarter of the dose. The youngest injected in our series was an infant of 6 months. Compression by means of an inflated rubber bag over the bladder region 10 minutes prior to and during

<sup>1</sup>Swick *Am J Surg* 1930 Feb pp 405-414.

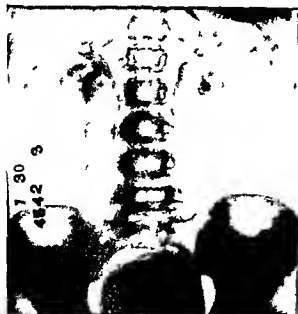


Fig 3 Pyelitis in girl 8 years of age. In the right kidney is shown moderate blunting of the calyces.

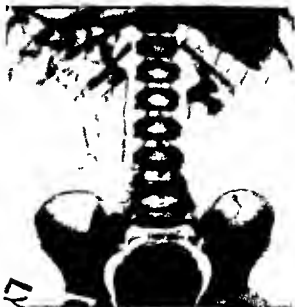


Fig 2 Pyelitis in a girl 5 years of age. No changes demonstrated by pyelography.

the time of roentgenographic exposures, markedly intensifies the pyelograms. It is advisable, however, to take one or two films without compression. The first roentgenogram is taken 15 minutes after the injection, the second 20 to 30 minutes after the first, and the third a corresponding period following the second. Subsequent plates depend on the findings of the first two, and



Fig 4 Pyelonephritis in girl 13½ years of age. Intravenous pyelogram shows slight blunting of calyces of left kidney.



Fig. 5. Pyelitis in girl 5½ years of age. The roentgenogram shows the right pelvis moderately dilated. A distinct loop is visible in the ureter below the pelvis with fairly well marked dilatation of the ureter below this point.



Fig. 7. Left renal tuberculosis in girl of 9 years. Diagnosis confirmed by nephrectomy.



Fig. 6. Intravenous pyelogram in a boy 11½ years of age, showing an area of destruction involving the left kidney. Infiltration of parenchyma with pyelographic medium radiating from the middle calyx, suggestive of tuberculosis. Nephrectomy performed and pathological diagnosis was circumscribed subacute purulent interstitial inflammation.



Fig. 8. Boy 7 years of age. Bilateral transplantation of ureters into sigmoid for ectopia vesicae. Most of the calyces in both kidneys somewhat blunted. A good deal of solution is seen throughout the entire colon.



Fig. 9. Girl 13 years of age who about 4 years ago had a plastic repair for large hydronephrosis of left kidney. Intravenous pyelogram now shows moderate dilatation of left kidney with evidences of stasis but good function.



Fig. 11. Intravenous pyelogram showing large congenital dysplastic hydronephrotic left kidney in girl 9 1/2 years of age.



Fig. 10. Boy 10 years of age. Pyelogram showing large hydronephrotic right kidney.



Fig. 12. Same patient as in Figure 11 showing more filling of sac and better visualization one half hour later.



Fig. 13 Congenital hydronephrosis in boy 8 years of age. Exposure made 2 1/4 hours after injection.



Fig. 14 Same patient as in Figure 13, 5 1/4 hours after injection. Pelvis and calyces more distended and show more intense visualization.

on the pathological process with which one is dealing. In the presence of any factor resulting in stasis, late plates usually give more information than the early ones.

To what extent intravenous urography will supplant cystoscopic procedures cannot as yet be determined. No doubt in many instances we will be able to dispense with cystoscopic pyelography. Since this test depends on the functional capacity of the kidneys, when there is poor function the intravenous radiograms are usually unsatisfactory and will have to be supplemented by the older method of retrograde pyelography. In renal neoplasms in children, in which the entire kidney is often destroyed by tumor tissue, there is very little or no visualization, and more information from a diagnostic point of view is afforded by the usual method of pyelography. Nevertheless, in this type of case, where there is a definite palpable tumor on one side, cystoscopy may be dispensed with if the other kidney visualizes normally. In pyelitis we have noted a blunting of the major and minor calyces and changes in the ureter outline, corroborating the findings of retrograde pyelography. The method should prove invaluable in the study of congenital anomalies and will no



Fig. 15 Same patient as in Figures 13 and 14, 9 1/4 hours after injection—retention in left but right fails to visualize.





Fig. 16. Congenital ureterohydronephrosis of left kidney in boy 11 years of age. Intravenous pyelogram taken 2 minutes after injection.

doubt bring to light many unsuspected conditions. In pyonephrotic and hydronephrotic kidneys the visualization will of course depend on the amount of functioning kidney parenchyma. This brings up the question of whether or not the functional value of this method bears any relation to the degree of visualization. Our experience would seem to indicate that when there is good visualization, the kidneys are probably functioning normally. Other factors, however (such as stasis, polyuria, roentgenological technique, the preparation of the patient, and obesity) must be taken into consideration, as all of these have their influence on the intensity of the shadows. In stasis due to mechanical causes, the late pictures become more and more intense, and plates taken 6 or 8 hours after injection show more distinctly and give more valuable information than early ones, which is exactly the opposite in normal kidneys.

The field of application of intravenous urography is very broad and as our experience pro-



Fig. 17. Roentgenogram taken 3 1/2 hours after injection in same patient as in Figure 16. Shows dilatation of lower end of ureter due to obstructive lesion at ureterovesical junction.

gresses, the indications will become pretty well standardized. In children it will probably be used more as a routine procedure than in adults. It is of especial value when for one reason or another cystoscopy cannot be performed or the ureters catheterized, in the presence of hamaturia and in cases in which the ureters have been transplanted into the bowel. Von Lichtenberg and Swick reported that in 75 per cent of injected cases the pyelogram gave satisfactory diagnostic information, whereas in 25 per cent cystoscopy and retrograde pyelography had to be resorted to for supplemental information.

In the study of these pyelograms our old concepts will have to be revised. For instance, serial roentgenograms of kidneys without any evidences of obstruction almost invariably show filling of the pelves and calyces. One would not expect, under normal conditions, to find this so, as we have been led to believe that the pelvis empties itself before it is completely filled. The injection produces considerable diuresis for a time, which may account in part for this phenomenon. The pictures are not as sharp as those obtained with retrograde pyelography, although in general the pelvis, calyces and ureters are well outlined.

In 22 children injected, reliable diagnostic data was obtained in most instances by intravenous urography alone. It was of particular service in 4 cases in which on account of severe cystitis the ureters could not be visualized. Almost all of these children were controlled by cystoscopy, functional tests, and in most instances cystoscopic findings were in accord with the pyelographic

<sup>1</sup>Figures 16 and 17 were loaned me by Dr. Jerome S. Leopold of Lenox Hill Hospital.

data. In obstructive conditions (hydronephrosis, ureter calculus, etc.), the degree of visualization cannot be entirely depended upon as a guide to the functional impairment of the kidney. Even though considerably damaged, sufficient substance may accumulate in the hydronephrotic sac to render a satisfactory degree of visualization. In the large uninfected hydronephroses, visualization of a normal kidney on the opposite side may be sufficient diagnostic data on which to base operative indications without resorting to cystoscopy. However, in conditions associated with pyuria, it will always be advisable to resort to cystoscopy and ureteral catheterization, even though the pyelogram shows an apparently normal kidney on the other side, as only by this means can we determine the presence of infection. Functional tests should always be made before deciding on intravenous pyelography, if there is poor function with marked blood retention, this procedure should not be used.

In conclusion, it may be stated that intravenous pyelography, especially in urology of children,

has already proved to be a most valuable diagnostic adjuvant. It is absolutely non toxic, and does away entirely with all the disadvantages of retrograde pyelography. It not only opens up new vistas, but will undoubtedly place urological diagnosis on an even more accurate basis than is at present possible. It is an entirely physiological procedure outlining the whole urinary tract and does away with artefacts caused by cystoscopic pyelography. It also settles once and for all the question of simultaneous bilateral pyelography, a procedure which has given rise to considerable adverse criticism during the past few years. Intravenous pyelography offers an excellent method of studying dynamic conditions of the kidneys and ureters, and from observations made so far offers us a radiographic functional test. For the present, until this method has been given a more extensive trial, it would seem advisable to supplement the examination by cystoscopy.

The accompanying illustrations demonstrate various conditions in which intravenous pyelography has been employed.

## THE TREATMENT OF IRREDUCIBLE INTUSSUSCEPTIONS IN CHILDREN

### A CLINICAL AND EXPERIMENTAL STUDY<sup>1</sup>

ALBERT H. MONTGOMERY, M.D., AND J. J. MUSSIL, M.D. CHICAGO

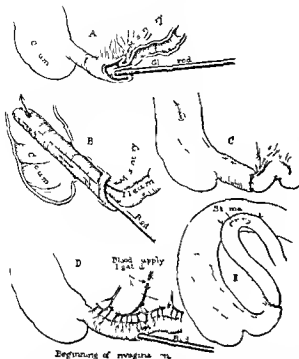
From the Otto S. A. Sprague Memorial Institute Laboratory at the Children's Memorial Hospital and the Department of Surgery at Rush Medical College, University of Chicago

ONE of the baffling pathological conditions that may confront the surgeon is an irreducible intussusception. The seriousness of this condition is augmented by the fact that most of them are found in very young children, since 80 per cent of intussusceptions occur in children under 2 years of age. In addition, these young patients are suffering from the toxæmia that is produced by an intestinal obstruction. That the seriousness of the situation cannot be minimized is seen in the careful review of 400 cases of acute intussusception made by Perrin and Lindsay. In cases of acute irreducible intussusception under all forms of treatment, they report a mortality of 100 per cent in children under 2 years of age and 70 per cent in older children. The surgeon who finds that his patient has an intussusception that he cannot reduce faces a grave problem. He may try various procedures such as (1) an artificial anus by making an enterostomy or a colostomy above the obstruction, leaving the intussusception in the

abdomen, (2) a lateral anastomosis around the obstruction leaving the intussusception in the abdomen, (3) a resection of the intussusception making an artificial anus of the ends of the bowel as in the Mikulicz's operation, (4) a resection of the intussusception with a lateral or end-to-end anastomosis, (5) a resection of the intussusception through an incision in the outer layer as in the Coffey operation.

Certain objections have been raised against each of the various operations. In these very young children, any operation which includes the making of an artificial anus will probably lead to a fatality as the infant loses too much food and water through the artificial opening. Other writers have objected to those operations which leave the intussusception in place as they think there is a grave danger in the sloughing that will follow. The ideal treatment, of course, is to remove the strangulated portion and re-establish the continuity of the bowel by anastomosis. Unfortunately,

<sup>1</sup>Read before the Chicago Surgical Society, January 4, 1930.



Beginning of invagination.

Fig 1 A Intussusception produced in the lower ileum by invagination with a glass rod B The intussusception pushed through the ileocecal valve into the ascending colon C The neck of the intussusception fixed by interrupted silk sutures D Portion of the lower ileum deprived of its blood supply by ligation before invagination E Lateral anastomosis between ileum and the ascending colon to short circuit around the intussusception

however, all such operations seem to be too formidable for young children. Although Kocher reported a successful outcome in 5 such cases,



Fig 3 Condition of bowel 5 days after ligating blood supply to invaginated bowel

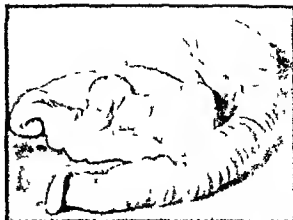


Fig 2 Condition of invaginated bowel after sloughing subsequent to blood supply ligation

other writers, for instance Perrin and Lindsay, had a mortality of about 100 per cent. The Coffey operation, in which a longitudinal incision is made in the outer layer and through this opening the intussusception is excised and its neck sutured, is performed in a highly infected field. It has not proved to be successful in our hands.

The method used occasionally by nature to cure some of these cases of irreducible intussusception is like the Coffey operation in principle. Treves in describing the condition says: "If the intussusception be irreducible then cure by spontaneous reduction is impossible as is also reduction by means of forcible enemata or by laparotomy. On the other hand if the tissues of the mass be glued together by adhesions about the neck, the parts are most advantageously placed for spontaneous recovery by elimination of the gangrenous intussusception." Thompson, in reporting a case of spontaneous cure by elimination, says that this



Fig 4 Showing stump of invaginated bowel after sloughing and anastomosis

TABLE I—RESULTS AFTER INVAGINATION OF 6 TO 10 INCHES OF ILEUM INTO AND THROUGH THE ILEOCAECAL VALVE AND FIXATION IN POSITION BY INTERRUPTED SUTURES THROUGH THE SEROSA

Dog No	Symptoms					No of days alive	Postmortem findings
	V	B S	L W	D	Dist		
1	—	—	—	—	—	43	Invagination spontaneously reduced and bowel normal
2	—	—	—	—	—	48	Invagination intact with edema of invaginated bowel but patent
3	—	—	—	—	—	53	Invagination intact with edema of invaginated bowel but patent
4	—	—	+	+	+	57	Bowel somewhat distended with signs of a mild obstruction
5	—	—	—	—	—	61	Invagination intact with a normal bowel
6	—	—	+	+	+	48	Signs of mild obstruction due to edema of invaginated bowel
7	—	—	—	—	—	2	Dog died of infection and emaciation
8	—	—	—	—	—	43	Invagination intact with a normal bowel
9	—	—	+	+	—	35	Edema of invaginated bowel but still patent and functioning
10	—	—	+	+	—	35	Edema of invaginated bowel but still patent and functioning
11	—	—	—	—	—	31	Invagination intact—bowel normal
12	—	—	—	—	—	24	Invagination intact—bowel normal
13	+	—	+	—	+	25	Invagination intact with a piece of bone lodged in bowel producing a partial obstruction

V—Vomiting B S—Bloody stool L W—Loss of weight D—Diarrhea Dist—Distention  
Average number of days that dogs lived is 42 These dogs were all killed

must have been a relatively frequent termination of intussusception in the period when these patients were all treated by non-surgical methods. He quotes from Leichtenstern's book published in 1879, in which it is stated that spontaneous elimination occurred in 42 per cent of 513 cases. Since the advent of surgery in the treatment of intussusception, reports of spontaneous elimination have naturally been somewhat rare. Fitzwilliams, in 1908, does not mention a single case in a series of 1,000 and Perrin and Lindsay, in 1921, said it did not occur in their series of 400 cases. Single cases have been reported by O Connor, Sherrin, and Sutcliffe.

It was only by taking advantage of this tendency to spontaneous cure that we were able to achieve

TABLE II—RESULTS OF INVAGINATION OF 8 TO 10 INCHES OF BOWEL, WHOSE BLOOD SUPPLY WAS SHUT OFF BY LIGATION AND RESECTION OF VESSELS, INTO AND THROUGH THE ILEOCAECAL VALVE AND FIXATION IN POSITION BY INTERRUPTED SUTURES THROUGH THE SEROSA

Dog No	Symptoms					No of days alive	Postmortem findings
	V	B S	L W	D	Dist		
1	+	—	+	+	+	35	Bowel distended for 5 feet with signs of sloughing of invaginated bowel
2	—	—	—	—	—	34	Strangulated bowel sloughed off with stricture of the stump but patent
3	+	+	+	+	+	37	Bowel enormously distended with sloughing and stricture of stump
4	—	—	—	—	—	1	Dog died of hemorrhage into bowel
5	+	+	+	+	+	48	Enormously distended bowel with sloughing and stricture of stump
6	+	+	+	+	+	36	Typical sloughing of bowel with stricture of stump but patent
7	+	+	—	—	—	2	Dog died of hemorrhage into bowel
8	+	+	—	+	+	5	Free blood in bowel with gangrene of strangulated portion
9	+	+	+	+	+	22	Typical sloughing with cicatricial contraction of the stump
10	+	+	+	+	+	41	Enormously distended bowel with the typical sloughing and stricture
11	+	+	—	+	+	5	Free blood in bowel with picture of acute obstruction
12	+	+	+	+	+	30	Typical picture of chronic obstruction with sloughing and stricture of stump
13	+	+	+	+	+	53	Typical picture of chronic obstruction with sloughing and stricture of stump
14	+	+	+	+	+	57	Typical picture of chronic obstruction with sloughing and stricture of stump

Average number of days that dogs lived is 34 This excludes the 2 dogs that evidently died from hemorrhage into the bowel

success in 2 cases after total failure in other cases in which the procedures involving resection already mentioned were used. Our good results were attained by simply fixing the intussusception in place by a row of interrupted silk sutures about the neck and then making a lateral anastomosis between the ileum and the colon distal to the intussusception. Our first patient was a girl, 7 months of age. From the history given by the mother and the objective findings, we felt that the

TABLE III—RESULTS OF INVAGINATION OF 8 TO 10 INCHES OF BOWEL—WHOSE BLOOD SUPPLY HAS BEEN SHUT OFF BY LIGATION AND RESECTION OF THE VESSELS—INTO AND THROUGH ILEOCECAL VALVE, AND ANASTOMOSIS OF THE LOWER PORTION OF THE ILEUM TO THE CÆCUM. DOGS WERE KILLED ON THE AVERAGE OF 60 DAYS AFTER OPERATION

Dogs	Symptoms	Postmortem findings
1	None	Bowel normal with sloughing of strangulated portion and healing
2	None	Bowel normal with sloughing of strangulated portion and healing
3	None	Bowel normal with sloughing of strangulated portion and healing
4	None	Bowel normal with sloughing of strangulated portion and healing
5	None	Slight distention of bowel but otherwise same as above
6	—	Dog died on the sixth day due to eversion
7	None	Bowel normal with typical sloughing and healing Stump not patent
8	None	Bowel normal with typical sloughing and healing Stump not patent
9	None	Bowel normal with typical sloughing and healing Stump not patent
10	None	Bowel normal with typical sloughing and healing Stump not patent
11	None	Bowel normal with typical sloughing and healing Stump not patent

These dogs gained weight and in general were in much better condition than at time of operation

child had an intussusception of 5 days' standing. At operation an irreducible intussusception was found at the ileocecal valve. The child's general condition was so poor at the time of operation that we felt that a resection would be fatal. We decided to leave the mass in place and fixed it by a row of interrupted sutures. Then a lateral anastomosis was made between the ileum and the colon. The patient made an uneventful recovery and left the hospital in 12 days. At no time could we find any evidences of sloughing tissue in the stools.

Our second patient was a little Italian boy, 8 months of age. According to his history the child had been sick for 2 days with an intussusception. When brought to the hospital, he was apathetic and apparently in poor condition. At operation an intussusception about 10 inches long was found. It consisted of the ileum that had invaginated itself into the cæcum. Part of the intussusception could be milked out but about 6 inches remained firmly fixed by a local adhesive peritonitis. The invaginated bowel was grayish black and began to

show signs of tearing when more force was applied in an attempt to free it. As it was evidently irreducible, the mass was left in place and fixed by a row of interrupted silk sutures around the neck. A lateral anastomosis was made between the lower ileum and the ascending colon. The child had a somewhat stormy convalescence because of an attack of bronchopneumonia. He left the hospital, however, at the end of a month in good condition. Daily examination of the stools failed to show any gross pieces of sloughed tissue.

Encouraged by the successful outcome in these two cases but realizing that our experience was too small to permit us to draw any definite conclusions we thought it would be worth while to try out this method of treating intussusceptions produced experimentally in dogs. With that object the following group of experiments was performed.

The operation, under ether anesthesia, consisted of a right rectus incision followed by the delivery of the lower end of the ileum and the cæcum into the wound. The lower 8 to 10 inches of the ileum was then invaginated into and through the ileocecal valve by means of a glass rod which was pointed at one end and blunt at the other (Fig. 1 A, B, and C). This portion of the bowel was chosen because of the frequency of intussusception at this point. No difficulty was experienced in invaginating the bowel provided a sufficient time was allowed to elapse to permit the ileum to relax following an initial spasm. Care had to be exercised not to strip the mesentery from the invaginating bowel. The bowel was fixed in position by means of interrupted silk sutures. However, after a series of 10 dogs it was discovered that the bowel disinvaginated itself by sliding out along the fat mesentery. Therefore it was found that a suture through the mesenteric attachment was necessary to hold the bowel in position.

The first group of dogs in general remained symptomless and in good condition despite the invagination. The invaginated bowel remained patent and there was, in most cases, very little pathological change present at postmortem (Table I). Frequently the only pathology present was a slight edema of the invaginated portion which apparently did not interfere with function of the bowel. This demonstrated in dogs that merely invaginating the bowel was not sufficient to produce interference to the blood supply with the resulting picture of intussusception as seen in man.

In the second group of dogs in addition to invaginating the bowel, the blood supply to that portion was first shut off by ligating and resecting

all the vessels supplying that section (Fig 1 D). These dogs had an uneventful recovery from the operation but in contrast to group 1, almost immediately began to lose weight, gradually become distended followed by vomiting, diarrhoea, bloody stools, and death (Table II). The postmortem revealed an emaciated dog with a very marked distended bowel, especially the lower end of the ileum (Fig 2). The strangulated portion of the ileum had sloughed off leaving a stump with a constricted lumen which was usually pulled to one side by the cicatricial contractions. It is interesting to note that all these dogs, with three exceptions, died of chronic obstruction to the bowel. The three exceptions were dogs, numbers 8 and 11, which died, showing a typical picture of acute obstruction (Fig 3) at the end of 5 days, and dog number 2, which was killed at the end of 34 days without any signs or symptoms of obstruction. The dogs lived on an average of 34 days.

In the third group, after shutting off the blood supply and invaginating as before, an anastomosis of the lower end of the ileum and caecum was done (Fig 1 E). These dogs in contrast to group II, almost immediately began to gain weight, were very active, and at no time showed any signs of obstruction. When killed at the end of 60 days on the average, they were fat, active, and in general in much better condition than at time of operation (Table III). Postmortem examination revealed a normal bowel with the strangulated portion sloughed off leaving a stump whose lumen, in most cases, was closed by cicatricial contractions (Fig 4).

#### SUMMARY AND CONCLUSIONS

Two young children with very definite irreducible intussusceptions were successfully treated by

fixing the irreducible part in position by a row of silk sutures placed about the neck and short circuiting this obstructed portion by a local anastomosis.

The rationale of this method of treating irreducible intussusceptions would seem to be supported by the results of experimental work done on dogs.

1 In dogs, in which a portion of bowel is invaginated and fixed, there is first a very strong tendency toward spontaneous reduction and in case the invagination remains in place, the bowel will function with little disturbance in the general health of the dog.

2 Invagination alone is not sufficient in dogs to produce an obstruction to the blood supply to the invaginated portion of the bowel.

3 Dogs in which the blood supply to a portion of the bowel is first shut off and then invaginated will die with a picture of chronic obstruction.

4 Lateral anastomosis of ileum to caecum around the intussuscepted portion of bowel will permit a normal function of the remainder of the bowel with no disturbance to the general health of the dog.

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#### CORRESPONDENCE

##### MARCUS WHITMAN—A CORRECTION

In the June number of *SURGERY, GYNECOLOGY AND OBSTETRICS*, the Editors published a portrait which bore the name of Dr Marcus Whitman. Stephen B. L. Penrose, president of Whitman College, who is the author of the biographical sketch of Dr Whitman, immediately objected to its publication.

It appears that there never has been an authentic portrait of Dr Whitman. The one in question is based upon an alleged resemblance between Dr Whitman and a clergyman who lived in Chicago. This same picture was published in the first edition of Dr O. W. Nixon's book, *How Marcus Whitman Saved Oregon*. Its publication was followed by a storm of protest from those who knew that it was

not genuine. At the time, Dr Penrose was criticized severely for its appearance in Dr Nixon's book. Consequently, he now feels that the publication of the photograph in connection with an article written by himself is a reflection upon his honor.

The Editors wish to state that this photograph was published in spite of Dr Penrose's insistence that there were no authentic portraits of Dr Whitman. In their zeal to present a likeness of the subject of Dr Penrose's sketch, they failed to place sufficient reliance upon the author's statement. They wish, therefore, to assume the responsibility for this error and to express their regrets to Dr Penrose for the occurrence of this unfortunate incident.

Unfortunately, the technique proposed for intravenous urography did not permit of general use, chiefly because of the necessity of establishing tolerance to the massive doses of sodium iodide necessary to cast a shadow, and because the shadow of the pelvis and ureter was frequently too indefinite for interpretation. Although the method suggested by Rowntree and his associates was not generally employed, nevertheless it is remarkable how clearly the renal pelvis and the bladder frequently can be outlined in patients who have become tolerant to iodine, after the intravenous injection of 200 cubic centimeters or more of a 15 per cent solution of sodium iodide. The discovery that intravenous urography was feasible stimulated various observers to find a solution more amenable for this purpose and the problem became one of chemistry.

It was evident that the greatest objection to solutions of sodium iodide employed was the fact that the iodine in its free form was poorly tolerated and did not permit greater concentration in the urine. It was necessary to find a combined form of iodine which would have none of the toxic qualities of the free iodine and would be secreted in a higher concentration. Roseno described a substance which combined iodine with urea and which was secreted in sufficient quantity clearly to outline the renal pelvis in many cases. Soon afterward he reported his experience in a number of patients with various lesions, in which he thoroughly evaluated the method and placed it on a clinical basis. Unfortunately, however, the substance was toxic to certain patients and consequently did not meet with general acceptance.

A combination of iodine in high concentration with a pyridine ring had been discovered previously by Binz and Raeth of Berlin, this was called "selectan neutral," and was being employed intravenously as an antiseptic

Among the first to work with this solution was Hryntschak, who as early as 1927 employed it to outline the urinary tract in animals, but was unable clearly to demonstrate its feasibility for general use. Swick, a fellow on the Libman Foundation, working with Lichtwitz at Altona, recognized early in 1929 the value of the selectan group in outlining the urinary tract following intravenous injection. However, it proved to be toxic in some cases and the shadow of the renal pelvis was frequently uncertain. Working with von Lichtenberg and Swick, Binz made various modifications which obviated the objectionable features, leaving a substance which on intravenous injection was not toxic and which outlined the pelvis and ureter sufficiently to permit interpretation of any existing abnormality. This substance was called "uroselectan." With characteristic Teutonic thoroughness von Lichtenberg insisted on an exhaustive trial by a group of representative American urologists before uroselectan should be distributed for general use, their results were submitted at a recent meeting of the American Urological Association.

Uroselectan is now available for use by the medical profession and undoubtedly will prove to be a valuable adjunct to general diagnosis. Judging from the experience of those who have employed it, its greatest value probably will be in determining the condition of the kidneys in cases in which ureteral catheterization is difficult or impossible. This would include in tolerant patients, patients with contracted tuberculous bladder, anatomical obstruction of the ureter, extensive vesical neoplasm, prostatic obstruction, impassable stricture of the urethra, patients who have undergone rectal implantation of the ureters, infants and patients in whom introduction of the cystoscope is difficult because of deformities. The intravenous method permits bilateral pyelography without any of the dangers accompanying bi-

lateral retrograde pyelography, this should be of particular value in the presence of polycystic kidney, bilateral hydronephrosis, and fused and solitary kidney. It will also be a valuable adjunct to the list of tests of differential renal function, which frequently have left doubt as to the functional capacity of the kidney under investigation. Incidentally, uroselectan offers a much better medium for retrograde pyelograms than sodium iodide in that it has none of the irritating qualities of the latter, and, because of the large content of iodine, it casts a dense shadow.

Although the method of intravenous urography is now available to the general profession, it must be remembered that the interpretation of the urogram is frequently difficult and should be referred to those who have had extensive experience.

It should be emphasized, moreover, that although in some cases the use of uroselectan may render cystoscopic examination unnecessary, nevertheless its interpretation will often have to be accompanied by cystoscopic data in order to complete the diagnosis.

It will be found that the outline of the pelvis and calyces is not always distinct in the urogram obtained by intravenous injection and that minor evidence of abnormality, such as occurs with renal tumor and renal tuberculosis, is easily overlooked. In doubtful cases a retrograde urogram will be necessary.

Thus, by the work of various contributors, intravenous urography has now been placed on a practical basis. That it will prove to be a valuable adjunct to urologic as well as to general abdominal diagnosis and surgery is evident.

WILLIAM F. BRAASCH, M.D.



# MASTER SURGEONS OF AMERICA

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## CHARLES ANDREW POWERS

CHARLES ANDREW POWERS, the son of George Eliot and Jennie Stow Powers, was born in Lawrence, Massachusetts, February 2, 1858. He attended the public schools of Massachusetts and began the study of medicine in 1879 under the direction of Dr. A. J. Stevens, of Malden, Massachusetts, who continued to serve as his preceptor during his undergraduate days at the College of Physicians and Surgeons of New York, from which in 1883 he received the degree of M.D.

It is unfortunate that his earlier biographical record can not be adequately written. His pre-medical education, the circumstances that led to his choice of medicine as a profession, as well as to his selection of surgery as a specialty, would unquestionably be of the greatest interest. He, however, rarely if ever, referred to his earlier years, and in spite of diligent inquiry from many of those of his classmates and intimate friends who still survive, these topics must unfortunately remain unanswered. That an ultimate surgical career was seriously considered by him when still a student is shown by his selection of the subject of "Intestinal Obstruction" for his graduating thesis. This, his first contribution to surgical literature, was unfortunately never published.

His student days in the College of Physicians and Surgeons must be passed over quickly. At that time "Twenty third Street" was a proprietary institution, and two full courses of lectures in seven subjects, extending over a period of at least two years and at a cost of two hundred and eighty dollars, were the sole qualifications for admission to the final examination. College intimacies and associations were not encouraged, and attendance at the didactic lectures was frequently irregular and at times entirely neglected. Students having university degrees, always in the minority, were ordinarily most industrious and ambitious and the majority of those on the "Honor Roll" or the first ten in each class, graded solely by the result of the final examination, were usually members of this group. On the other hand, those without previous college experience were frequently dazzled by the opportunities for pleasure which the "Great White Way" (in those days it was the "Red Light District") afforded, and their medical education suffered accordingly. Powers, however, although handicapped by the lack of a previous college education, was diligent and painstaking and while he



CHARLES A POWERS  
1858-1922



was not a member of the magic "Honor Roll," his scholarship and medical knowledge were such that he successfully passed the acid test of a competitive hospital examination and was appointed an interne on the house staff of the "House of Relief" which was the emergency receiving department of the New York Hospital. Here in 1883 and 1884 he served for 16 months, the last four of which as house surgeon, and attracted the favorable attention of Dr W T Bull, the visiting surgeon to the hospital, to whom, after further study abroad in Paris, Heidelberg, and London, he became a personal assistant. This association, of which Powers was justly proud, marked most auspiciously the beginning of his surgical career, for Bull was most popular and capable and inspired both devotion and energy in those who were fortunate enough to attract his friendly interest. Guided by such a mentor, Powers was soon placed in charge of the surgical outpatient department of the New York Hospital, and a year or two later was appointed visiting surgeon to the St Luke's and Cancer Hospitals. For several years, associated with his classmate J E Newcomb, he conducted recitations in anatomy and surgery in an extramural quiz and undoubtedly profited greatly by this experience in teaching. At that time the college curriculum, consisting entirely of didactic lectures, was supplemented by quizzes conducted by groups of recent graduates, which had no official connection whatever with the organization of the medical school. These quizzes were voluntarily patronized by ambitious students who could afford the added expense, for internes were appointed to the more desirable hospitals only after competitive examinations, and as these were always keenly contested, the personal instruction given members of a well organized quiz undoubtedly enhanced their chances of ultimate success.

Only the strongest constitution could have endured the demands of so great a burden of professional work, and it was not at all surprising that Powers' health became impaired. St Luke's Hospital was at that time a hot bed of tuberculosis, and it is more than possible that his pulmonary infection may have been contracted "in the line of professional duty." As soon as the diagnosis was corroborated he left New York for Saranac and in 1894, after a year in the Adirondacks, he moved to Denver, Colorado.

It is impossible to conceive how keen his disappointment must have been when he was compelled to forego his brilliant prospects in New York. He was undoubtedly on the high road to professional and social success. Many loyal friendships were suddenly interrupted and this sacrifice alone must have proved a cruel hardship. To blows of much less intensity many have succumbed and have aimlessly, and without achievement, lived out their allotted time. Not so with Powers! Improved in health and with the dreaded infection at a standstill, he figuratively "rolled up his sleeves" and in a surprisingly short time became a leader in the surgical profession of the city of his adoption. He was appointed professor of surgery in the medical department of the University of Colorado,

and in 1896 was elected a fellow of the American Surgical Association. In 1901 the honorary degree of M. A. was conferred on him by the University Staff of which he had become a member.

Instead of acting as a depressant, the tubercular virus circulating in his system seemed to act as a stimulant and gave him renewed vigor. It is possible that it even enhanced his professional skill, for instances of this nature are not unknown. Under a similar handicap the distinguished Stevenson was most productive and his works have a literary charm that it is difficult to surpass. In the medical profession the much beloved Trudeau achieved a national and international reputation and the sanatorium for tuberculosis which he founded in Saranac will always serve as a mute memorial to his professional skill.

The career of Powers in Denver was tantamount to that which he would have achieved in New York. In an interesting obituary notice by his colleague, Dr. Freeman of Denver, it is stated that "at various times he was surgeon to most of the hospitals in Denver." He was a member of numerous surgical societies both in this country and abroad. From his membership in the American Surgical Association and the American Society of Clinical Surgery he derived the greatest satisfaction, not only because of the scientific value of their meetings, but chiefly because of the opportunities afforded for close and intimate friendships with fellow members. He served the American Surgical Association as vice president in 1903, as treasurer from 1906 to 1912, as president in 1912, and from 1906 to 1916 as a member of its council.

Though never the author of a textbook or extensive surgical treatise, Powers was a prolific contributor to surgical literature. From the very beginning he participated actively in the surgical discussions of the state and other local societies and these discussions were both earnest and convincing. The writer recalls no meeting of the American Surgical Association in which he did not contribute a paper and in the meeting of 1909, two papers (a most unusual occurrence) were read by him.

In his surgical work Powers could not be called a brilliant or daring operator. In this field he never cultivated the "dramatic" quality. On the contrary, he was careful, conscientious, and painstaking in his surgical technique, rather than speedy in mechanical execution. In consultation, skill in diagnosis was probably his greatest asset, to which his wide experience and reading, his keen power of observation and a naturally analytical mind largely contributed.

He was justly proud of his military services in France and to his own country during the world war. Whether or not he contemplated military service in the Spanish American war of 1898 is not known. It is probable that he was deterred from taking part in this conflict by his comparatively recent tuberculous infection. In 1908, however, the first year of its organization, he was appointed a lieutenant in the U. S. Medical Reserve Corps. Shortly after the outbreak of the

world war, keenly sympathetic with France, he retired from civil practice and became an attending surgeon to the American Ambulance Hospital in Paris. With few interruptions he remained abroad until the close of the war. In July, 1917, he was appointed major in the medical corps of the U S Army and assigned to duty in the American Hospital, No 1, at Neuilly, receiving his discharge in December, 1918. On returning home he became a lieutenant-colonel in the U S Reserve Corps. In recognition of his services abroad he was awarded the *Medaille de la Reconnaissance Française*, elected a Chevalier of the Legion of Honor, and an officer of the order of Leopold II of Belgium. Congress awarded to him the distinguished service medal which, arriving too late to be presented to him before his death, was pinned, at his funeral in Denver, upon the uniform in which he was buried. His body was interred in Arlington Cemetery.

At the close of the war, Powers did not, like many others, resume surgical practice. While he could have afforded to have rested on his well earned laurels, his energy and his desire to be of public service did not abate. Perhaps the tubercular virus was still active. He soon took the greatest interest in the Society for the Control of Cancer to which he was chosen president and to the affairs of which he gave his undivided attention. The wide publicity campaign against this terrible scourge was largely directed by him, and, although the end is unfortunately not yet in sight, he contributed most effectively to the growth of this most important activity.

In this brief résumé of the career of Dr Powers, little has been said of his domestic life and personal traits. His marriage, contracted relatively late in life did not prove fortunate and had only a brief existence. To his friends he was both loyal and helpful. His standards were naturally high and unprofessional conduct of all kinds excited his displeasure. This in itself provoked certain animosities. No one of strong character is without enemies and these were treated always with a certain ironical sarcasm which bordered on contempt. Perhaps a reliable measure of character is the number and strength of the friendships an individual enjoys. Of equal if not of greater value, is the attitude of the younger generation toward their chief. In the former Powers was particularly fortunate, and in the latter, the sincere admiration and at times even of affection in which he was held by his juniors was a personal tribute that must have afforded him the greatest satisfaction. Like Gulliver in the *Lilliputians*, he was well fortified against the pricks of adverse or hostile criticism.

In addition to membership in the important social clubs of Denver, Powers was a member of the Century Association in New York. This was a favorite "sanctuary" to him in his frequent visits east, and he enjoyed intimate contact with many of its members. At the annual meeting shortly following his death a touching tribute was paid him by the secretary of the association, Mr Alfred Dana Noyes.

On December 23, 1922, Dr Powers died suddenly in Denver of cerebral apoplexy. His death occurred without premonition or any previous disturbance of his mental faculties. He had shown no lack of interest in his various activities nor had any diminution in the energy with which he approached different problems been observed. When he was stricken he was in the midst of dispatching Christmas cards to friends at home and abroad. How much to be envied is such an end to a busy and fruitful career! How vastly preferable to the lingering illness and gradually increasing incapacity so often observed in the final illness of those advanced in years! And, then too, what more perfect message could one wish to bequeath his fellow men than the expressions of peace and good will to all which his Christmas cards conveyed. The continued esteem and affection of one's surviving friends is a much to be envied tribute to which all may aspire but which few attain. Powers, or "Charlie" Powers as he was affectionately known to many friends, undoubtedly had the rare distinction of so living in the hearts of those who enjoyed the privilege of his friendship.

ELLSWORTH ELIOT, JR





DE  
**RATIONE CVRANDI**  
**PER SANGVINIS MISSIONEM,**  
*Libri Decem.*

In quibus extirpatis erroneis opinionibus passim hodie  
apud nonnullos vigentibus, omnia ad hoc argumentum  
pertinentia, secundum Galeni doctrinam explanantur.

A V T H O R E

**HORATIO AVGENIO MEDICO, ET PHILOSOPHO**  
*hac nostra aetate praestantissimo.*

Addidimus eiusdem disputationem adversus A. Mercenarium ordinariam  
Philosophum in Patavino Gymnasio profectorem.

**ILLVSTRISS ET REVERENDISS..D.**  
**VINCENTIO LAVREO S. R. E.**  
**CARDINALI AMPLISS**  
D I C A T I



**TAVRINI, Apud Io. Baptistam Katterium. M D LXXXIII.**

Cum Licentia Superiorum.

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M D, F A C S, OMAHA, NEBRASKA

### THE BLEEDING MANUAL OF AUGENIUS

IN order to understand clearly the importance of this little book which went through three editions between 1575 and 1597, it is necessary to review the changes in medical doctrine and thought leading up to the great argument concerning bleeding which was taking place during the sixteenth century. From the earliest times the idea that disease was caused by some changes in the blood was almost universal. Hippocrates believed this to be a "pneuma" or air which was present in the blood and a change in it gave rise to disease. Consequently, in order to relieve the body of this poison, the drawing of a certain amount of blood at a definite time was indicated in various diseases. Hippocrates believed that venesection should be done according to the theory which he called revulsion. That is, that the blood should be withdrawn from the same side of the body which was diseased and should be withdrawn in fairly large quantities. In this he worked upon the idea that withdrawal of the blood from the abnormal part allowed new blood to come in and help to cure the disease. The ideas of Hippocrates were, many of them, controverted by Galen, and his followers—the Arabian physicians. Galen and the Arabians consequently introduced a new theory. This they called derivation and the technique consisted in drawing blood from a part of the body distant from the site of the lesion, usually the other side of the body, and withdrawing it very slowly, drop by drop, the idea being, that in this way the blood was brought away from the part involved and the part was deprived of its injurious blood. They believed that the theory of Hippocrates was wrong, for they thought that the abstraction of blood near the diseased part in large quantities only brought new blood to the parts and so increased the lesion by the introduction of new blood which was already poisoned.

The employment of the Galenic and Arabian method was almost universal until the early part of the sixteenth century. At this time Brissot, a physician of Paris, who had studied the works of the ancient Greek physicians and had been quietly practicing the Hippocratic method of bleeding, came out in 1515 with the open statement that the Hippocratic method was the best one to follow. He had tried it in several cases of pleurisy during an epidemic and found that it was much more valuable than the Arabian method. Immediately his opponents were up in arms and a medical war was started which

waged for nearly a century with unabated activity and with lesser activity continued well into the nineteenth century. It seems to us a rather minor matter to have caused so much trouble, but to give an idea of the seriousness of the problem and the bitterness of the quarrel at that time it is only necessary to remember that after Brissot had won over to his side members of the faculty of Paris his opponents obtained a parliamentary decree which stated that his method should not be used, and Brissot had to leave his country and go to Portugal.

Horatius Augenius took sides in the controversy and joined the opponents of Brissot who believed in the doctrines of Galen and the Arabian physicians. He was born in 1527 in the town of Monte Santo in northern Italy. He was the son of a physician, Ludovicus Augenius, who was one of the physicians to the Pope. After an excellent education he decided to go into teaching work. At first, being educated in other things than medicine, he taught logic at the University of Macerata. Then he became professor of theoretical medicine at Rome. He left there a few years later and went to several other towns, still teaching. In 1577 he changed from the theoretical to the practical side of medicine and succeeded Francesco Vallenola as professor of practical medicine at the University of Turin. Finally as the crowning event in his teaching life he was called by the Republic of Venice to the University of Padua, and there remained until his death in 1603 at the age of 76 years.

In his dedication to Cardinal Vincentius Laureus, Augenius lays down what he expects to do in his book. He reviews briefly the prevailing quarrel in the medical profession regarding the letting of blood and places himself squarely on the side of the Galenic doctrine. He states that many are advancing opinions which are not only erroneous but also of great danger to the human race. He says that these men are not really mistaken but err only in that they do not understand the ideas of Galen, and he states that if Galen were alive at this time, or if they had lived at the time of Galen, they would thoroughly understand the subject and there would be no argument. He then goes on to say that he intends to clear up the points under discussion and make the entire medical profession understand the error of the ways of part of it and get together and avoid argument by accepting his views which are correct. Thus he endeavors to do in the first eight books of his work.

## REVIEWS OF NEW BOOKS

THE seventh and eighth revised editions of Professor Schilling's book<sup>1</sup> is an edited translation by a man who states in the preface that he made a pilgrimage to Professor Schilling's laboratory. It therefore probably represents a clear statement of the ideas of the author. The translation appears to be well done and the typography is excellent.

The book is divided into four parts. Part I deals with technique which is an essential introduction to the remaining portions. Part II is an exposition of the theory, morphology and division of the blood picture. In Part III are stated the fundamental principles for clinical use of the blood picture. Part IV is composed of selected examples of practical use of hæmograms. Some of the technical procedures are new and have strange names e.g. The Gutta diaphot and will have to be tried out by American clinicians and laboratory workers before they are accepted with the same enthusiasm as that shown by the translator. The most significant part of the book has to do with the blood picture which must be explained in order to give any clear conception of the substance of the book and its value. The normal blood picture is made up of circulating generally matured (although not of the same age) highly differentiated cells mixed in rather constant proportions. Cell consumption (physiologic degeneration) occurs peripherally in the circulating blood, i.e., by destruction in the spleen or through emigration into and consumption in the tissues together with reduction of their number. The products of cell consumption stimulate blood regeneration. Cell substitution (physiological regeneration) comes from the centers the count is increased without normally changing the blood picture. A pathological change in the blood picture takes place if these two functions are increased and their limits displaced and interfered with. As long as regeneration which according to biological laws compensates for every loss is equivalent to degeneration sufficient or even increased substitute material is furnished by the accelerated and increased formation and sending forth of normal cells or their juvenile forms respectively (hypertrophy) it is only after over stimulation and impending exhaustion that the normal primary blood cells reduce into less developed or even dedifferentiated earlier stages (hyperplasia). On the basis of this theory of the blood picture Schilling has devised a hæmogram which he asserts to be of very great diagnostic and prognostic value. In Part IV the author cites a great number of cases illustrating the use of the hæmogram in diagnosis and prognosis. The book will doubtless prove useful to the skilled laboratory worker.

A SECOND monographic treatise on the adrenal glands by Goldzieher<sup>2</sup> is more complete than his first book since it includes most of the modern literature on the subject as well as a consideration of the normal and pathological morphology and function of the adrenals and an interpretation of their disturbances as related to clinical medicine. It is a complete and comprehensive review of the subject. One hundred and twenty four pages are devoted to the anatomy and physiology of the adrenals and eighty two pages to pathological anatomy. The remainder of the book is devoted to clinical syndromes and interrelationships and organotherapy. A very useful classified and extended bibliography covers almost one hundred pages. The author attempts considerable worth while analysis but occasionally expresses opinions unnecessarily based on faith rather than facts. He is well acquainted with the controversial nature of many points relative to the physiology of the adrenals and protects his views by the statement "It is obvious that a much more exact knowledge is necessary to make the neuro chemical mechanism of endocrine regulations clearly intelligible." Considered as a whole the book is briefly inclusive analytical but quite hypothetical. The reader is pleased to note however, that the author does not press insecure claims and frequently writes to the effect that additional evidence is necessary to make these complicated matters more clear and there is a wide and fruitful field for future clinical or experimental investigations. The book is well outlined the subject matter is clearly expressed and can be read with interest and profit by any physician or student interested in the subject. It is a contribution to the subject since it is a systematic discussion of the investigations on the physiology and pathology of the adrenals.

A C IV

IT seems to be a custom among book reviewers to pick out the defects and errors for the purpose of placing a great deal of emphasis on them. A *Textbook of the Practice of Medicine*<sup>3</sup> by various authors edited by Frederick W. Price, published by the Oxford University Press contains 1758 pages and naturally I have not read it through. I have read however a number of the major contributions in a critical spirit. Having failed to find anything which, in my opinion could be improved by change I began to search for omissions.

Subjects which one would expect to find only in a very extensive reference work are covered adequately in this textbook. Such subjects as—the recent work on undulant fever, carbon monoxide poisoning

<sup>1</sup> THE BLOOD PICTURE AND ITS CLINICAL SIGNIFICANCE (INCLUDING TYPICAL DISEASES). A Guidebook on the Microscopy of the Blood. By Professor Dr. Victor Schilling. Translated and edited by R. B. H. Gradwohl. M.D. 7th and 8th rev. ed. St. Louis: The C. V. Mosby Co. 1929.

<sup>2</sup> THE ADRENALS: THEIR PHYSIOLOGY, PATHOLOGY, AND DISEASES. By Max A. Goldzieher. M.D. New York: The Macmillan Company 1919.

<sup>3</sup> A TEXTBOOK OF THE PRACTICE OF MEDICINE. INCLUDING SECTIONS ON DISEASES OF THE SKIN AND SPECIAL MEDICAL MEDICINE. By various authors. Edited by Frederick W. Price. M.D. F.R.S. (Edin.) 3rd ed. New York and London: Oxford University Press 1929.

poisoning by tetro ethyl gasoline, lead encephalopathy, lethargic encephalitis and its sequelæ are treated as fully as could be desired.

Twelve hundred sixty nine pages of the text are devoted to the subject of general medicine, and the most attractive chapters are on fever and immunity, subjects which are seldom discussed in a one volume text. One hundred pages are devoted to diseases of the skin and 387 pages to nervous and mental diseases. The latter section is unusually concise, lucid, and yet comprehensive. I envy the editor and wish that I could place a copy of this text in the hands of every interne and student. In view of the size of the work, the publishers have seen fit to print the text on a paper which is so thin that it is not sufficiently opaque to prevent the print from showing through. This minor defect is more than compensated by the reduction in size and weight of the book.

WILLIAM H. HOLMES

THE pioneer stage in the clinical use of blood plasma measurements is covered in Rowntree and Brown's book on *The Volume of the Blood and Plasma in Health and Disease*.<sup>1</sup> From personal use of the method, I know it to be simple, rapid, and harmless. The book contains a mass of tabulated data of blood volume determinations by the originators of the method. An honest critique of the procedure is given and the technique described. The normal values are made from determinations on 40 normal men and 25 normal women. These figures seem to represent an inadequate basis for general clinical application. The remainder of the volume presents the available data—usually scant—in a variety of pathological conditions.

The monograph is a small one, uniform with the other numbers of the Mayo clinic series, but it is essential to anyone interested in the use of this method.

PAUL STARR

IN a volume of two hundred pages,\* Kidd and Simpson review 650 cases of common infections of the female urethra and cervix, studied over a period of 20 years. One is greatly impressed with the careful method with which the cases have been studied from a clinical as well as a bacteriological standpoint. The discussions on gonorrhoeal arthritis, prophylaxis, and general methods of diagnosis are of outstanding interest.

While intra uterine douching and forceful vaginal douches recommended by the author will not be universally approved, nevertheless the volume as a whole is interesting, and makes very good reading. Descriptions of diseases of the external genitalia are accurate.

EUGENE A. EDWARDS

<sup>1</sup>THE VOLUME OF THE BLOOD AND PLASMA IN HEALTH AND DISEASE. By Leonard G. Rowntree, M.D., and George E. Brown, M.D., with the technical assistance of Grace M. Roth. Philadelphia and London: W. B. Saunders Company 1929.

\*COMMON INFECTIONS OF THE FEMALE URETHRA AND CERVIX. By Frank Kidd, M.A. M.Ch. (Cantab.) F.R.C.S. (Eng.) and Malcolm Simpson, B.A. M.B. D.Ph. (Cantab.). 2nd ed. New York and London: Oxford University Press 1929.

IN any treatise on radiography of uterus and tubes one naturally looks first for a reference to Kennedy, whose work was the logical outcome of Rubin's ingenious design. But so short is the memory of medical men nowadays that credit is often given more from personal or nationalistic preference, and in Beclere's book,<sup>2</sup> salpingography, essentially an American invention, starts from the demonstration of the harmlessness of lipiodol by Sicard and Forestier, and is developed almost exclusively by French authors. I do not wish to lay unction to my soul, but it seems to me that in America we are rather punctilious in giving credit where credit is due, without regard to political boundaries.

Aside from these historical inaccuracies, however, Beclere has produced a good book, I may even say, an extremely good book on the subject. He has injected iodized oil in 270 cases and taken almost 1000 roentgenograms, of which 70 are reproduced in this volume in an excellent manner. That is an imposing material and an admirably thorough search which demand respect.

In 44 cases of sterility he found complete occlusion of both tubes in more than one half and a diminished permeability in more than one fourth of the cases, and only in 18 per cent were the tubes patent. In the large majority of all cases, gonorrhoea was the etiological factor. In 70 cases of salpingitis, the infection resulted in tubal occlusion in 57 per cent, and left the patency of the tubes undisturbed only in 13 per cent. Contrary to general assumption the author believes that a mild gonorrhoeal infection primarily leads to hydrosalpinx, and that pyosalpinx and tubo ovarian abscess are due to reinfection of a primary hydrosalpinx. Streptococcal infection injures the tubal mucosa far less frequently and intensely than does the gonococcus.

In sterility, oil injection should be made only after any cervical infection has been treated and definitely eliminated. The examination will then reveal, first, any abnormal condition within the uterine cavity, second, the state of the tubes and the exact location of any obstruction. Incidentally, this purely diagnostic procedure has a possible therapeutic value, since pregnancy has followed such examination in about 10 per cent of the cases. Where a tubal obstruction has been demonstrated, the roentgenogram will point the way to rational treatment. Unnecessary operations on the uterus could be excluded, and the cases would be indicated where salpingostomy or reimplantation of the tubes is required.

After the clinical cure of a salpingitis, radiography throws light on the prognosis as far as conception is concerned, and when only one tube is found patent, the other, occluded tube may be removed.

This is only the gist of Beclere's conclusions, but the interested reader—and who is not interested in

<sup>2</sup>LA PERMEABILITÉ ET LES OBSTRUCTIONS TUBAIRES STÉRILITÉ IN FÉCTIONS SALPINGITIQUES. CHIRURGIE TUBAIRE. By Claude Beclere. Paris: Masson et Cie 1929.

tubal radiography at present<sup>2</sup>—will also find many valuable hints as to the proper technique.

The final evaluation of tubal oil injections depends on their innocuousness. Of this the author is convinced for he has had but one case of acute salpingitis in 270 patients. But he knows of one fatal case in America and half a dozen more or less serious peritoneal inflammations in France. Is that really the sum total of all complications? Are accidents as readily published as successes? The author himself warns against dangers from using too much pre-sure. Lastly, what becomes of the oil which oozes from the open ends of the tubes? We know from the days of August Martin and later Pfannenstiel that plain oil irritates the peritoneum and iodine oil should be less irritating.<sup>3</sup> From my own experience I can testify that in one case the oil injection first proved the patency of the tubes and then caused a pelvic peritonitis and produced occlusion. In 10 years perhaps the method will be only of historical value. For the present however it is intensely interesting and important, as long as we can be sure that the oil will not pass through the tubes into the peritoneal cavity.

GEORGE GELLHORN.

ONE of many textbooks of gynecology for nurses on the market Gellhorn's little book has the distinction of being the only one that gives a brief and much needed history of gynecology in addition to a simple and easily understandable discussion of the female genital organ in health and disease. Part II on gynecological nursing is especially well done presenting the main points of methods of examination therapeutic measures and details of pre-operative and postoperative care in a manner intelligible and helpful to the nurse interested in that aspect of medicine. The illustrations are good and do much to supplement and clarify descriptions within the text. The book is written from the point of view of the nurse and is to be highly recommended as a textbook for general use.

MARK T. GOLDSTEIN.

IN the past few years a number of manuals dealing with the injection treatment of hemorrhoids have been published. Among these the book of L. Goldbacher, *Hemorrhoids: the Injection Treatment and Pruritus Ani*<sup>1</sup> is worthy of mention. The first few chapters are devoted to the surgical anatomy, pathology, symptoms and classification of the different types of hemorrhoids. The author states that he has not observed a single recurrence of hemorrhoids when the phenolized oil injection method has been used properly, but that he has seen the return of hemorrhoids after surgical excision. I do not believe however that this is the experience of every proctologist.

A special prepared needle is used by Goldbacher and the solution consists of 5 per cent dry phenol crystals dissolved in Wesson oil. While the technique is fully described only a few rules to be observed will be mentioned. Only internal hemorrhoids should be treated with this method and the injection should never be made below the mucocutaneous junction. If a pure white spot appears at the site of the injection, the needle point is too superficial. A prolapsed hemorrhoid must not be injected until it is returned into the rectum.

As to pruritus ani the author is of the opinion that tissue spaces and channels, often of microscopic size exist in the perianal and rectal tissues. These channels convey irritating products and their discharge sets up a pruritic irritation.

The object of the treatment is to obliterate these channels. He advocates the injection of a 5 per cent phenolized oil through the perineum at the site of irritation. The needle is introduced about one half inch from the rectum and inserted to a depth of about three fourths of an inch and about 5 to 10 cubic centimeters is injected. This should not produce any pain, or abscess or complication of any kind.

Submucosal injections are also made, on the supposition that these channels may exist under the mucous membrane of the lower rectum. These injections are made through the anoscope. This form of treatment should not be started until the rectum has been relieved of all other rectal disease. The author reports gratifying results with this form of treatment.

C. J. DE BREE.

A POINT much in its favor is that *Clinical Obstetrics*<sup>2</sup> is easy to read. It is designed to supplement the usual textbook on obstetrics. Its aim is to formulate a general plan of clinical procedure in the management of an obstetrical case—a laudable undertaking. 'When and why an operative measure is instituted are far more important than the facility with which it is carried out.'

The chapters on Bandl's ring and breech are excellent. This does not mean that the rest of the chapters are poor, but that these two stand out particularly well. His recommendations in regard to the use of pituitary extract are good.

To some points brought out by Harper, however, the reviewer would take exception. For instance his reference to hamostasis due to uterine retraction, his statement that it is not necessary to paint the skin and vulva with iodine or mercurchrome in the ordinarily clean case, his recommendation that nourishment be given in small amounts during labor, his suggestion to use manual dilation of the cervix in so many conditions, his statement 'while it is best not to invade the infected puerperal uterus, there would seem to be no justification for an expectancy that leaves necrotic material or a removable focus of infection in place', his neglect to mention the use of

<sup>1</sup>GYNECOLOGY FOR NURSES. By George Gellhorn MD FACS Philadelphia W. B. Saunders Company 1930.

<sup>2</sup>HEMORRHOIDS: THE INJECTION TREATMENT AND PRURITUS ANI. By Lawrence Goldbacher MD Philadelphia F. A. Davis Company 1930.

<sup>3</sup>CLINICAL OBSTETRICS. By Paul T. Harper Ph.D. M.D. Sc.D. FACS Philadelphia F. A. Davis Company 1930.

the tracheal catheter in asphyxia of the newborn, and the lack of detail in the chapter on hyperemesis gravidarum.

In spite of these criticisms the book is well worth a trial.  
E L CORNELL

THE book by T. Henry Treves Barber on varicose veins<sup>1</sup> is very well written and the subject, with few exceptions, is thoroughly covered. The author is cautious in determining the indications for the injection treatment of varicose veins, in fact, he is more conservative than the majority of men doing his work either abroad or in the United States. While Dr. Treves Barber prefers the 15 per cent solution of sodium chloride, he discusses all solutions used. He is an enthusiastic advocate of the injection treatment of varicose veins and believes that the surgical treatment is a thing of the past. He does not mention the supportive treatment of varicose veins, a method which has now passed through the experimental stage and has been found to give results far superior to those from any other method of treatment.

There is a scarcity of plates and photographs in the book, but this is not regarded by some as of great importance. No bibliography is given, but all in all the book is one of the best on the market at the present time and I believe that it is superior to any from the European press. It is well worth the price to any man doing this work.  
H O McPHEETERS

THE fourth edition of Jellett's *Manual of Midwifery* has been thoroughly revised by Madill, an ex assistant master of Rotunda Hospital. The volume still represents the teachings and practice of the Rotunda. The chapters on eclampsia, the treatment of contracted pelvis, the etiology of antepartum hemorrhages have been rewritten, new sections have been added to the sections on anæsthesia during labor, pyelitis during pregnancy, nephritic toxæmia and pre eclamptic toxæmia. New illustrations have been added here and there. The volume retains the nomenclature peculiar to English authors, in many places without reference to terms in common usage.

The reviewer feels that in the main the advice given is safe, although in a few instances he would do otherwise. The use of a metal urinary catheter in a patient in labor is rather dangerous. The advice to make vaginal, in preference to rectal, examinations is to be regretted. In the treatment of pyelitis of pregnancy no mention is made of cystoscopic examination or the insertion of the ureteral catheter. This is well recognized treatment in selected cases.

Considerable space is given to the operation of pubiotomy. It is strongly recommended as the

operation of choice in certain cases of contracted pelvis. Why risk a mutilating operation of this type when the low cervical cesarean section gives such good results? The chapters on antepartum hemorrhage and eclampsia are particularly well done.  
E L CORNELL, M D

IN his recent work, *Stone in the Urinary Tract*<sup>2</sup> H P Winsbury White, a London urologist, stresses no one factor in his discussion of etiology of calculi but mentions geographical influences, variety of water, physicochemical reactions of colloids, bacterial agociæ, and vitamin deficiency as possible factors.

Contrary to other contemporary workers, this author believes that many urinary calculi are not opaque to the X ray, especially those composed of uric acid, xanthin, and cystin.

The pathology of renal stones consists of changes due to back pressure and infection. Similar to current American belief, non interference is advised in cases of large bilateral calculi. Renal stones may be silent or manifested by fixed pain, or typical radiating renal colic or referred pain. It is surprising to note, it is contended that lining epithelial cells of the kidney pelvis can be differentiated in the urine by the microscope. Since the advent of the cystoscope and roentgen ray, exploratories for renal calculi are unjustifiable.

Prophylactic dietary measures to be followed in various calculi are discussed. The best conservative treatment of any renal calculus is early removal. In spite of its awkwardness, the author uses fluoroscopy at the operating table. In cases of multiple urinary calculi of different location, as a rule, the one located lowest down is removed first.

The author believes that ureteral stones should be given an opportunity to pass spontaneously, if the stone is not passed, careful and deliberate cystoscopic ureteral manipulation is advised. Ureterotomies are done extra peritoneally.

Only a few pages are devoted to the general considerations of calculous anuria.

Because of their common occurrence, vesical calculi receive ample consideration. Dr White does not use spinal anæsthesia, because of the attendant risk to the patient. His caution not to use too much fluid in a bladder for instrumentation is very timely. If lithotomy *per urethram* is contra indicated, median perineal litholapaxy is advised.

Urethral stricture is the most common predisposing cause of urethral calculus. A primary urethral calculus is rare. Most stones of the anterior urethra can be removed with proper forceps. Urethrotomy can always be done. Calculi of the posterior and prostatic urethra are attacked perineally by Dr White. Prostatic and preputial calculi are described. There are separate chapters on urinary calculi in children and pregnant women.

<sup>1</sup> THE TREATMENT OF VARICOSE VEINS OF THE LOWER EXTREMITIES BY INJECTION. By T. Henry Treves Barber M D B Sc. New York: William Wood and Company, 1929.

<sup>2</sup> A MANUAL OF MIDWIFERY FOR STUDENTS AND PRACTITIONERS. By Henry Jellett M A M D (Dub Univ.) F R C P I L M, and David G. Madill B A M D B Ch BAO (Dub Univ.) L M. New York: William Wood and Company, 1929.

<sup>2</sup> STONE IN THE URINARY TRACT. By H P Winsbury White M B Ch B (Edin.) F R C S (Edin.) F R C S (Eng.) Philadelphia: J. B. Lippincott & Son and Company, 1929.

One seldom has the opportunity of encountering as fine a bibliography as is incorporated in this volume on stone in the urinary tract

This book is beautifully and adequately illustrated. It affords to the physician, a working volume of principles on urinary calculi. HARRY CULVER

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE INTERNATIONAL MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. Edited by Carey F. Coombs M.D. FRCP and A. Rendle Short M.D. B.Sc. FRCS. 48th year. New York: William Wood and Company, 1930.

DISEASES OF THE NOSE, THROAT AND EAR. MEDICAL AND SURGICAL. By William Lincoln Ballenger M.D. F.A.C.S. 6th ed. rev. by Howard Charles Ballenger M.D. F.A.C.S. Philadelphia: Lea & Febiger, 1930.

A MANUAL OF DISEASES OF THE NOSE AND THROAT. By Cornelius G. Coatsley A.M. M.D. F.A.C.S. 7th ed. rev. Philadelphia: Lea & Febiger, 1930.

PHYSIKALISCH-CHEMISCHE PROBLEME IN DER CHIRURGIE. By Dr. C. Haebler. Berlin: Julius Springer, 1930.

DIE ENTZÜNDENDEN ERKRANKUNGEN DER WEIBLICHEN GESCHLECHTSORGANE IHRE WESEN IHRE ERKENNUNG UND BEHANDLUNG. By Prof. Dr. C. Bucura. Vienna: Julius Springer, 1930.

LES HYDROPHROSES ANATOMIE ET PATHOGENIE. By Edmond Papin. Paris: G. Doin et Cie, 1930.

DER EINFLUSS DES GESCHLECHTSVERKEHRS AUF DAS BEFINDEN DER FRAU. By Dr. Heinrich Offergeld. 2d ed. Stuttgart: Ferdinand Enke, 1930.

DIE NASEALS REFLEXORGAN DES AUTONOMEN NERVEN SYSTEMS. By Dr. Alfred Koblanck. With foreword by Prof. Dr. Friedrich Matthaei. Berlin and Vienna: Urban & Schwarzenberg, 1930.

THE ACTION OF MUSCLES INCLUDING MUSCLE REST AND VITAL RE EDUCATION. By Sir Colin Mackenzie M.D. F.R.C.S. F.R.S. (Edin.). 2d ed. New York: Paul B. Hoeber Inc., 1930.

A MANUAL FOR A DEMONSTRATION COURSE IN OBSTETRICS. By Reuben Peterson A.B. M.D. F.A.C.S. Ann Arbor: Michigan Edwards Brothers, 1930.

A TEXT BOOK FOR MIDWIVES. By John S. Fairbairn M.A. B.M. B.Ch. (Oxon.) F.R.C.I. (Lond.) F.R.C.S. (Eng.). 5th ed. London and New York: Oxford University Press, 1930.

DISEASES OF THE URINARY TRACT IN CHILDREN. By Edwin Beer M.D. and Abraham Hyman, M.D. New York: Paul B. Hoeber Inc., 1930.

RADIUM AND CANCER (CURIETHERAPY). By Duncan C. L. Fitzwilliams M.B. M.D. Ch.M., F.R.C.S. New York: William Wood & Company, 1930.

A SYNOPSIS OF SURGERY. By Ernest W. Hey Groves M.S. M.D. B.Sc. (Lond.) F.R.C.S. (Eng.). 9th ed. New York: William Wood and Company, 1930.

NURSING IN EMERGENCIES. By Jacob K. Berman A.B., M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1930.

SURGICAL DIAGNOSIS. By American authors. Edited by Everts Ambros Graham A.B. M.D. Vol. III also index to vols. I to III. Philadelphia and London: W. B. Saunders Company, 1930.

COLLECTED PAPERS OF THE MAYO CLINIC AND THE MAYO FOUNDATION FOR 1929. Vol. XVI. Edited by Mrs. Mellich Richard M. Hewitt, B.A., M.A. M.D. and Mildred A. Feller, B.S. Philadelphia and London: W. B. Saunders Company, 1930.

SONDERBAFENDE ZUR STRAHLENTHERAPIE. Vol. XIV. Tabellen zur Dosierung der Röntgenstrahlen. By Prof. Dr. L. Grebe and Dr. Phil. K. Nitzge. Berlin and Vienna: Urban & Schwarzenberg, 1930.

METHODS AND PROBLEMS OF MEDICAL EDUCATION (SEVENTEENTH SERIES). New York: The Rockefeller Foundation, 1930.

CHEMISTRY IN MEDICINE, A CO-OPERATIVE TREATISE INTENDED TO GIVE EXAMPLES OF PROGRESS MADE IN MEDICINE WITH THE AID OF CHEMISTRY. Edited by Julius Steiglitz. New York: The Chemical Foundation Inc.

SOME ASPECTS OF THE CANCER PROBLEM, AN ACCOUNT OF RESEARCHES INTO THE NATURE AND CONTROL OF MALIGNANT DISEASE COMMENCED IN THE UNIVERSITY OF LIVERPOOL IN 1905 AND CONTINUED BY THE LIVERPOOL MEDICAL RESEARCH ORGANIZATION (FORMERLY THE LIVERPOOL CANCER COMMITTEE), TOGETHER WITH SOME OF THE SCIENTIFIC PAPERS PUBLISHED. Edited by W. Blair Bell B.S., M.D. (Lond.) F.R.C.S. (Eng.), F.A.C.S. (Hon.) New York: William Wood and Company, 1930.

CURIO MEDICA. A SERIES OF PRIMER ON THE HISTORY OF MEDICINE. Edited by E. B. Krumpholtz M.D. Vol. I—The Beginnings—Egypt and Assyria. By Warren R. Dawson F.R.S.E. Vol. II—Medicine in the British Isles. By Sir Dr. Arcey Power K.B.E., F.R.C.S. (Eng.). Vol. III—Anatomy. By George W. Corner M.D. New York: Paul B. Hoeber, 1930.

THE SKIN REACTIONS, BLOOD CHEMISTRY AND PHYSICAL STATUS OF NORMAL MEN AND OF CLINICAL PATIENTS. By William F. Petersen M.D. and Samuel A. Levinson, M.D. Chicago: American Medical Association, 1930.

COLLECTED PUBLICATIONS FROM THE ROBERT DAWSON EVANS MEMORIAL FOR CLINICAL RESEARCH AND PREVENTATIVE MEDICINE. No. 1—Endocrine Studies. Boston: F. J. Barraud & Co. Inc., 1930.

REPORT ON FIFTH INTERNATIONAL CONGRESS OF MILITARY MEDICINE AND PHARMACY. London: England: May, 1929. By Commander William Seaman Bainbridge M.C. F. Menasha Wisconsin: The Collegiate Press, 1930.

PHYSICAL DIAGNOSIS. By Richard C. Cabot M.D. 10th rev. ed. New York: William Wood and Company, 1930.

DISEASES OF WOMEN. By ten teachers. Under the direction of Comyns Berkeley M.A. M.D. M.C. (Cantab.) F.R.C.P. (Lond.) F.R.C.S. (Eng.). Edited by Comyns Berkeley, H. Russell Andrews J. S. Fairbairn. 4th ed. New York: William Wood and Company, 1930.

INJURIES TO JOINTS. By Sir Robert Jones Bart. K.B.E. C.B. Ch.M. I.R.C.S. I.A.C.S. 3d ed. New York and London: Oxford University Press, 1930.

NEW AND NON-OFFICIAL REMEDIES 1930 CONTAINING DESCRIPTIONS OF THE ARTICLES WHICH STAND ACCEPTED BY THE COUNCIL ON PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION ON JANUARY 1, 1930. Chicago: American Medical Association, 1930.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

MERRITTE W. IRELAND, Washington, *President*

C. JEFF MILLER, New Orleans, *President Elect*

FRANKLIN H. MARTIN, Chicago, *Director General*

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## PROGRAM FOR THE 1930 CLINICAL CONGRESS IN PHILADELPHIA

**A** PRELIMINARY program or schedule of the clinics and demonstrations to be given in the hospitals and medical schools of Philadelphia during the twentieth annual Clinical Congress of the American College of Surgeons, October 13-17, as prepared by the Committee on Arrangements, appears in the following pages. The surgeons of Philadelphia expect to provide for the visiting surgeons a complete showing of the clinical surgical activities of that great medical center, the actual program to include clinics in all branches of surgery—general surgery, gynecology, obstetrics, orthopedics, urology, surgery of the eye, ear, nose and throat. The program as here published is merely an outline or basis for the complete program for the five days' session. During the weeks preceding the Congress the program is to be revised and amplified in order to present a more complete outline of the clinical work to be demonstrated. Clinics are scheduled to begin at 2 o'clock on Monday afternoon and for the mornings and afternoons of each of the four following days.

The real program of the Congress, which will present a complete and detailed schedule of the clinics to be given at each of the hospitals together with detailed programs for all conferences, scientific sessions, etc., will be issued daily during the Congress in the form of bulletins, which will be posted at headquarters each afternoon presenting the clinical schedules for all hospitals for the following day. Printed bulletins containing the same material will be distributed each morning.

As a special feature of the clinical program, the Committee is arranging for a series of fracture clinics at several of the large hospitals demonstrating modern methods in the treatment of fractures, which forms so large a part of surgical work in large cities and industrial centers.

In the following pages will be found the program for a series of clinical demonstrations in ophthalmology and otolaryngology to be held in the ballroom of the Bellevue Stratford Hotel each morning except Monday. These demonstrations, as arranged by a sub-committee of Philadelphia ophthalmologists and otolaryngologists, will be held in the forenoon in view of the fact that the clinical work in these specialties will be presented at the hospitals in the afternoon.

Motion picture films that have been produced under the supervision of or approved by the Board on Medical Motion Pictures will be shown at a series of film exhibitions to be conducted at headquarters daily except on Monday. A number of films will be given their premier showing in Philadelphia. There will also be shown a number of outstanding contributions not comprised in the College library of films, including several new "sound" pictures.

At the annual meeting of the College, on Thursday afternoon at 2 o'clock, formal reports on the activities of the College will be presented by the officers and several standing committees. At the conclusion of the annual meeting there will be presented a symposium on cancer dealing with the scientific aspects of this problem.



Plans for the entertainment of visiting ladies are under consideration by the Executive Committee and it is probable that a series of automobile tours visiting the important historic points in and around Philadelphia will be arranged.

Clinical Congress headquarters will be established at the Bellevue Stratford Hotel, corner of Broad and Walnut Streets. All of the large rooms on the first floor including the grand ballroom which will be used for the evening scientific meetings, the hospital conference on Monday, the annual meeting and other large gatherings, together with several of the large rooms on the roof and the Stratford room on the main floor, have been reserved for the use of the Congress, and will be utilized for scientific meetings, conferences, film exhibitions, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc.

Space has been reserved in the Stratford Room on the main floor, the Clover and Red Rooms and other large rooms on the first floor, for the Technical Exhibition in which will be represented the leading manufacturers of surgical instruments, X-ray apparatus, operating lights, hospital apparatus of all kinds, pharmaceuticals, publishers of medical books, etc.

#### EVENING MEETINGS

The Executive Committee of the Congress is preparing programs for a series of five evening meetings to be held in the ballroom of the Bellevue Stratford Hotel. On Monday evening at the Presidential Meeting following the introduction of distinguished guests from abroad and the address of the retiring president, Major General Merritt W. Ireland, Washington, the president elect, Dr. C. Jeff Miller of New Orleans will deliver his inaugural address. Mr. George Grev Turner Newcastle of Tyne, England, professor of surgery in the University of Durham and Hunterian professor and member of council of the Royal College of Surgeons of England will deliver the Murphy oration in surgery on that occasion.

Among the distinguished visitors from abroad who will present papers at the scientific meetings are William Ernest Miles, F.R.C.S., surgeon to the Gordon Hospital for Rectal Diseases and the Cancer Hospital of London, who will present a paper on 'Cancer of the Rectum', Professor Othfried Foerster, of the University of Breslau, Germany, who will discuss the surgical treatment of neurogenic contractures, Professor Emile de Grosz, of Budapest, Hungary, who will present a paper on ophthalmological surgery.

At the annual Convocation of the College on Friday evening the 1930 class of candidates for Fellowship in the College will be received. The Fellowship address will be delivered by Dr. George W. Crile, of Cleveland, Ohio.

The annual oration on fractures will be delivered by Dr. Dallas B. Phemister, Professor of Surgery at the University of Chicago.

Three major subjects form the basis for the programs for the evening meetings: plastic surgery including the treatment of burns, injuries, contractures and congenital deformities; surgery of the kidneys, bladder and ureter, and thoracic surgery. Distinguished surgeons of the United States and Canada have been invited by the committee to present papers dealing with these subjects. A complete program for the evening meetings will be published in the next issue of this journal.

#### CANCER CONFERENCE

Under the auspices of the Committee on the Treatment of Malignant Diseases, with Robert B. Greenough, of Boston, Chairman, a round table conference will be held on Thursday morning on the subject of cancer clinics, cancer hospitals and cancer institutes. At this conference plans for the organization and administration of such institutes will be discussed by members of the committee who will present the methods recommended by the committee for securing more widespread efficient care for cancer patients. Opportunity will also be afforded to representatives of existing and proposed cancer clinics of the different types to present questions on the administration and professional conduct of such clinics.

On Thursday afternoon following the annual meeting and under the auspices of the same committee there will be a symposium on cancer to include the presentation of several papers dealing with the scientific aspects of the problem. A detailed program will be published in the October issue of this journal.

Preparations are being made at some of the Philadelphia hospitals where cancer clinics are being conducted for demonstrations or dry clinics dealing with the subject of cancer.

#### CONFERENCE ON TRAUMATIC SURGERY

A conference on traumatic surgery is being arranged for Friday, with sessions both morning and afternoon, at which leaders in industry, education and labor together with the representatives of indemnity companies, surgeons and hospital administrators, will discuss various phases of this activity of the College. The program for the conference includes the following:

- Report on the Work of the Committee on Traumatic Surgery in Recent Years Its Present and Future Activities **FREDERIC A. BESLEY**, Waukegan, Ill., Chairman
- Injuries to the Shoulder Joint **ERNEST AMORY CODMAN**, Boston
- Treatment of Injuries of the Knee Joint **WILLIS C. CAMPBELL**, Memphis, Tenn.
- Treatment of Fractures by Skeletal Traction **SAMUEL R. CUNNINGHAM**, Oklahoma City, Okla.
- Application of the Compensation Act in the State of New York **LYNDSEY ROGERS**, New York
- Discussion of the Automobile Accident Situation in Relation to Payment for Hospital Care **EMIL FRANKEL**, Director of Research, New Jersey Department of Institutions and Agencies, Trenton, N. J.

## HOSPITAL STANDARDIZATION CONFERENCE

For the thirteenth annual hospital standardization conference which opens at 9 30 o'clock on Monday morning, October 13th, in the ballroom of the Bellevue-Stratford Hotel, an interesting program of papers, round table conferences, and practical demonstrations that deal with the problems related to the hospital standardization program of the College and to hospital efficiency in general is being prepared

Monday, 9 30-12 00

- Opening Address **Major General MERRITT W. IRELAND**, Washington, President, American College of Surgeons
- Presentation of the Thirteenth Annual Report of Hospital Standardization **FRANKLIN H. MARTIN**, M.D., Chicago, Director General, American College of Surgeons
- Our Responsibility as Fellows of the College in Furthering the Hospital Standardization Movement **C. JEFF MILLER**, M.D., New Orleans, President Elect, American College of Surgeons
- What the Hospital Standardization Movement Means to the Present Day Practice of Medicine **GEORGE W. CRILL**, M.D., Cleveland, Director, Cleveland Clinic
- My Conception of an Ideal Hospital **Rev. ALPHONSE M. SCHWITALLA**, St. Louis, Dean St. Louis University School of Medicine, President, Catholic Hospital Association
- Is Standardization of Hospital Surgical Procedures Possible? **JOSEPH C. DOANE**, M.D., Philadelphia, Director, Jewish Hospital
- The Liaison Committee—A Means of Promoting Cooperation Between the Medical Staff and the Hospital Management **J. GARLAND SHERKILL**, M.D., Louisville, Visiting Surgeon, Louisville Public, Jewish, and St. Mary and St. Elizabeth Hospitals

Monday, 2 00-5 00

- IRVING D. JENNINGS**, M.D., Brooklyn, Clinical Professor of Surgery Long Island College Hospital, Surgeon, St. Catherine's Hospital, presiding
- A Study of Acute Appendicitis at St. Catherine's and Greenpoint Hospitals, Brooklyn, from 1919 to 1929 inclusive, for the Purpose of Evaluating the Benefit of Staff Conferences **JOSEPH S. BALDWIN**, M.D., Attending Surgeon, Greenpoint and Holy Family Hospitals, **HARRY FELDMAN**, M.D., Associate Sur-

geon, Greenpoint Hospital, **JOHN A. MCCABE**, M.D., Assistant Surgeon, Greenpoint and St. Catherine's Hospitals, **JOSEPH L. PFEIFFER**, M.D., Assistant Surgeon St. Catherine's Hospital, **WALTER J. O'CONNELL**, M.D., Assistant Surgeon, St. Catherine's Hospital

Co-ordination and Integration of the Gynecological Obstetrical Service in a General Hospital **CHARLES A. GORDON**, M.D., Brooklyn, Clinical Professor of Obstetrics and Gynecology, Long Island College Hospital, Attending Obstetrician and Gynecologist, Greenpoint and St. Catherine's Hospitals

A Plan for the Organization and Control of the Courtesy Staff in a General Hospital **JOHN M. SCANNELL**, M.D., Jamaica, N. Y., Attending Surgeon, St. Catherine's Hospital, Brooklyn, Attending Surgeon, Mary Immaculate Hospital, Jamaica

Problems of the Rural Surgeon and Their Solution **JOHN B. MCKENZIE**, M.D., Loggville, N. B., Surgeon, Hotel Dieu, Chatham

Is the Private Patient Getting a Square Deal? **JOHN F. JENNINGS**, M.D., Surgeon in Chief, Cumberland Hospital, Surgeon, Brooklyn and St. Peter's Hospitals

Tuesday, 9 30-12 30

Important Basic Considerations in Maintaining an Adequate X-ray Service in Various Sized Hospitals **EDWARD S. BLAINE**, M.D., Chicago, Radiologist Wesley Memorial Hospital

Autopsies Their Value and Certain Factors that Will Influence Their Increase **B. HERMAN MASON**, M.D., Waterbury, Conn., Superintendent, Waterbury Hospital

Absorption of Special Charges in Hospitals (illustrated) **LAWRENCE C. AUSTIN**, Milwaukee, Superintendent, Mount Sinai Hospital

The Hospital's Teaching Responsibility **JOHN I. RANSOM**, Baltimore, Assistant Director, Johns Hopkins Hospital

Tuesday, 2 00-5 00

Round Table Conference—Functions, Relationships, and Responsibilities of the Board of Trustees, Medical Staff, and Superintendent Conducted by **C. W. MUNGER**, M.D., Valhalla, N. Y., Director, Westchester County Department of Hospitals

Wednesday, 9 30-12 30

Organization of the Record Department (illustrated) **PAUL H. FESLER**, Minneapolis, Superintendent University Hospitals

Centralization of Medical Statistics in the Record Department **MARY M. NEWTON**, R.N., Pittsburgh, Medical Statistician, Pittsburgh Homeopathic Hospital

Role of the Student Nurse in the Clinical Record **MARY MERRILL**, Williamsport, Student Nurse, School of Nursing, Williamsport Hospital

Care Records and Clinical Conferences **IRVING D. METZGLER**, M.D., Pittsburgh, President Pennsylvania State Board of Medical Education and Licensure

Wednesday, 2 00-5 00

Round Table Conference—Medical and Hospital Economics Conducted by **ROBERT JOLLY**, Houston, Texas, Superintendent, Baptist Hospital Educating the Public, Costs versus Value of Medical and Hospital Services Medical and Hospital Economics in relation

to planning and construction management scientific departments (clinical laboratory X ray and physical therapy), Standardization of Equipment and Supplies

For Thursday forenoon, those attending the hospital conference are invited to attend a round table conference on the subject of cancer clinics, cancer hospitals and cancer institutes, and on Friday morning a conference on traumatic surgery. The afternoons of those two days will be devoted to visits to the Philadelphia hospitals with demonstrations on hospital equipment, construction, management, etc. All persons interested in the hospital field are invited to attend the hospital conference.

#### REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Philadelphia session of the Clinical Congress so that the total fare for the round trip will be one and one half the ordinary first class one way fare. To take advantage of the reduced rates it is necessary to pay the full one way fare to Philadelphia procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be deposited at headquarters for the signature of the general manager of the Clinical Congress and the vice of a special agent of the railways. Upon presentation of a valid certificate to the ticket agent in Philadelphia not later than October 21st a ticket for the return journey by the same route as traveled to Philadelphia may be purchased at one half the one way fare.

In the eastern central and southern states and eastern provinces of Canada tickets may be purchased between October 9th and 15th, in other sections of the United States and Canada at somewhat earlier dates. The return journey from Philadelphia must be begun not later than October 21st.

The reduction in fares does not apply to Pullman fares, nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale rates routes etc. Stop overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to Philadelphia, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and valid by a special railroad agent in Philadelphia during the meeting. No

reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used to Philadelphia and that the certificate must be deposited at headquarters during the meeting and return ticket purchased and used not later than October 21st.

An exception to the above arrangement is to be noted in the case of persons traveling from points in certain far western states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including September 30th with a final return limit of October 31st. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in certain of the far western states and British Columbia. Tickets sold at summer excursion rates permit traveling to Philadelphia via a direct route and returning via another direct route with liberal stop-over privileges.

#### SPECIAL TRAIN FROM CHICAGO

For the convenience of men living in the central and western states who will attend the Congress in Philadelphia, the Pennsylvania Railroad will undertake to provide a special train leaving Chicago at 1:45 p.m. on Sunday, October 12th, arriving in Philadelphia at 8:45 a.m. on Monday, October 13th. This special train will duplicate the equipment and schedule of the famous Broadway Limited, and will include standard Pullman sleeping compartment, club, observation and dining cars. No extra fare will be charged for passage on this special train. Members are urged to make their reservations for the special train at the earliest possible date through their local ticket agents or by direct application to Mr. R. C. Caldwell, Division Passenger Agent, Pennsylvania Railroad, 33 North LaSalle Street, Chicago. The proposed arrangement is contingent upon reservations for such special train being made by the minimum number required by the Interstate Commerce Commission rules.

#### LIMITED ATTENDANCE—ADVANCE REGISTRATION

Attendance at the Philadelphia session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheatres, operating rooms, and laboratories in the hospitals and medical schools to determine their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets. This plan provides an efficient means for the distribution of the visiting surgeons among the several clinics, and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

#### REGISTRATION FEE

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

#### PHILADELPHIA HOTELS AND THEIR RATES

There are ample first-class hotel facilities available in Philadelphia for all who will attend, as in recent years a number of fine hotels have been built. Many of the hotels are located within walk-

ing distance of the headquarters hotel. The following hotels are recommended by the Committee on Arrangements.

	Minimum Rates with Bath	
	Single Room	Double Room
Adelphia, 13th and Chestnut Sts	\$ 4.00	\$ 7.00
Barclay, Rittenhouse Square East	6.00	8.00
Bartram, 33rd and Chestnut Sts		8.00
Belgravia, 1817 Chestnut St	4.00	7.00
Bellevue Stratford, Broad and Walnut	5.00	7.00
Benjamin Franklin, 9th and Chestnut	4.00	7.00
Colonial, 11th and Spruce Sts	4.00	7.00
Drake, 1512 Spruce St	5.00	8.00
Elks, Broad and Vine Sts	2.50	5.00
Gladstone, 11th and Pine Sts	4.00	7.00
Green's, 8th and Chestnut Sts	3.00	4.50
Lorraine, Broad and Fairmount Ave	5.00	9.00
Maidstone, 1327 Spruce St	3.00	5.00
Majestic, Broad and Girard Ave	4.00	6.00
Mayfair, Lincoln Drive and Johnson St	5.00	8.00
Pennsylvania, 30th and Chestnut Sts	3.00	5.00
Rittenhouse, 22nd and Chestnut Sts	3.00	5.00
Ritz Carlton, Broad and Walnut Sts	6.00	10.00
Robert Morris, 17th and Arch Sts	3.50	5.00
St. James, 13th and Walnut Sts	3.50	5.00
Stephen Girard, 2027 Chestnut St	3.00	5.00
Sylvania, Juniper and Locust Sts	4.00	8.00
Tracy, 36th above Chestnut St	3.00	5.00
Walton, Broad and Locust Sts	3.50	5.00
Warwick, 17th and Locust Sts	5.00	8.00
Wellington, 19th and Walnut Sts	5.00	6.00
Westbury, 15th and Spruce Sts	5.00	10.00

## PRELIMINARY CLINICAL PROGRAM

## GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

## TEMPLE UNIVERSITY HOSPITAL

*Monday*

WILLIAM A STEEL—1 Surgical operations  
 W HERSEY THOMAS—3 Genito urinary surgery  
 TEMPLE FAY—3 Surgical treatment of epilepsy  
 ELGENE P PENDERGRASS—3 Surgical radiologic con-  
 ference roentgenologic diagnosis of hypertrophied  
 gastric mucosa and pedunculated tumors of the  
 stomach prolapsing into the duodenum  
 FRANK W KONZELMAN—4 Surgical pathological con-  
 ference

*Tuesday*

TEMPLE FAY—9 Neurosurgical clinic encephalography  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11  
 Operative gynecology  
 HARRY HUDSON—1 Orthopedic surgery  
 TEMPLE FAY—3 Management of traumatic injuries to  
 the brain  
 ELGENE P PENDERGRASS—3 Surgical radiological con-  
 ference roentgenologic diagnosis of liver abscess and  
 subdiaphragmatic collections  
 FRANK W KONZELMAN—4 Surgical pathological con-  
 ference

*Wednesday*

WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic spinal cord tumor  
 cases  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant  
 patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12  
 Operative gynecology  
 WILLIAM A STEEL—1 General surgical operations  
 H Z HIRSHMAN—3 Atypical neuralgia and trigeminal  
 neuralgia  
 ELGENE P PENDERGRASS—3 Surgical radiological con-  
 ference roentgenologic study of the neck and upper  
 respiratory tract  
 FRANK W KONZELMAN—4 Surgical pathological con-  
 ference

*Thursday*

TEMPLE FAY—9 Neurosurgical clinic cerebellar tumor  
 cases  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12  
 Operative gynecology  
 WILLIAM A STEEL—12 Buerger's clinic operative and  
 ambulant cases  
 JESSE ARNOLD—1 Obstetrics  
 TEMPLE FAY—3 Neurosurgical clinic hydration states  
 normal in eclampsia and uremia and acute toxic  
 states  
 ELGENE P PENDERGRASS—4 Surgical radiological con-  
 ference  
 FRANK W KONZELMAN—4 Surgical pathological con-  
 ference

*Friday*

WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic gangliectomy of  
 sympathetomy  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant  
 patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—12  
 Operative gynecology  
 WILLIAM A STEEL—1 Operative surgery  
 W HERSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Neurosurgical clinic  
 ELGENE P PENDERGRASS—3 Surgical radiological con-  
 ference cephalography  
 FRANK W KONZELMAN—4 Surgical pathological con-  
 ference

## JEFFERSON HOSPITAL

*Tuesday*

P BROOKE BLAND and staff—9 Gynecology and ob-  
 stetrics  
 J TORRANCE RIGH and staff—10 Orthopedics  
 J CHALMERS DA COSTA and staff—11 General surgery  
 THOMAS C STELLWAGEN and staff—11 Genito urinary  
 surgery  
 JOHN H GIBBON and staff—2 General surgery

*Wednesday*

BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and ob-  
 stetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary  
 surgery  
 J CHALMERS DA COSTA and staff—2 General surgery

*Thursday*

P BROOKE BLAND and staff—9 Gynecology and ob-  
 stetrics  
 THOMAS C STELLWAGEN and staff—10 Genito urinary  
 surgery  
 J CHALMERS DA COSTA and staff—11 General surgery  
 J TORRANCE RIGH and staff—11 Orthopedic surgery  
 P BROOKE BLAND and staff—4 Obstetrics

*Friday*

BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and ob-  
 stetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary  
 surgery  
 JOHN H GIBBON—11 General surgery

## U S NAVAL HOSPITAL

*Tuesday*

Staff—9 Surgical operations

*Wednesday*

Staff—9 Surgical operations

*Thursday*

Staff—9 Surgical operations

*Friday*

Staff—2 Discussion of surgical cases or surgical topics

## UNIVERSITY HOSPITAL

Tuesday

CHARLES C. NORRIS, C. A. BEHNEY and D. P. MURPHY  
—9 Gynecological operations and demonstration of cases

DRS. MULLER, OVERHOLT and RADEMAKER—9 Surgical clinic, abdominal cases

FREDUND B. PIPER and staff—9 Obstetrical operations

C. H. FRAZIER and F. C. GRANT—9 Neurosurgical clinic

DRS. MULLER, OVERHOLT and RADEMAKER—2 Dry clinic

Special tests used in the study of vascular disturbances, opaque solutions available in the roentgenological study of surgical patients, factors in the production of chills following intravenous infusions, intraperitoneal and intrapleural pressure relationships, the course of events in acute appendicitis

I. S. RAVDIN—2 Gall bladder surgery, operations and demonstration of cases

C. H. FRAZIER and F. C. GRANT—2 30 Neurosurgical clinic, demonstration of interesting cases

Wednesday

FLOYD E. KEENE and staff—9 Gynecological operations

L. L. ELIASON and staff—9 General surgical clinic

F. C. GRANT—9 Neurosurgical clinic

A. BRUCE GILL and staff—2 Orthopedic surgery, dry clinic with demonstration of end results

Thursday

C. H. FRAZIER and F. C. GRANT—9 Neurosurgical operations

DRS. MULLER, OVERHOLT and RADEMAKER—9 Surgical clinic, thoracic cases, operations and demonstration of cases

FREDUND B. PIPER and staff—9 Obstetrical operations

DRS. MULLER, OVERHOLT and RADEMAKER—2 Dry clinic Results in the surgical treatment of lung abscess, methods of treating empyema, presentation of follow up chest cases of lung abscess, bronchiectasis, chronic empyema and pulmonary tuberculosis

A. BRUCE GILL and staff—2 Orthopedic operations

B. J. ALPERS—2 30 Neuropathological conference

Friday

C. H. FRAZIER—9 Neurosurgical clinic

FLOYD E. KEENE and staff—9 Gynecological operations

FREDUND B. PIPER—9 Obstetrical operations

L. L. ELIASON and staff—9 Fracture clinic

## ST AGNES HOSPITAL

Monday

WILBUR HAINES and I. MICELI—2 Urological clinic

Tuesday

E. C. MURPHY—9 General surgical clinic

LEONARD AVERETT—10 Gynecological clinic

Wednesday

J. W. BRANSFIELD—9 General surgical clinic

G. M. DORRANCE—2 General surgery and cleft palate clinic

WILBUR HAINES—2 Urological surgery

Thursday

J. I. V. JONES—9 General surgical clinic

JOHN A. MCGILVER—10 Gynecological clinic

W. W. VAN DOLSEN—15 Obstetrical clinic

Friday

G. M. DORRANCE—9 General surgical clinic

WILBUR HAINES and I. MICELI—2 Urological clinic

## LANKEAU HOSPITAL

Monday

JOHN B. DEVER—12 General surgical clinic

WILLIAM MACKINNEY—3 Cystoscopy

Tuesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests

DR. HAMMETT—9 Chemistry of cell division

MRS. MCNETT—9 Exhibition of drawings of pathological specimens

MISS JASTROW—11 Exhibition of follow up service

ROBERT SHOEMAKER—11 X ray demonstration

Wednesday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests

DR. HAMMETT—9 Chemistry of cell division

MRS. MCNETT—9 Exhibition of drawings of pathological specimens

COLBY ENGEL—9 Injection treatment of varicose veins

MISS JASTROW—11 Exhibition of follow up service

ROBERT SHOEMAKER—11 X ray demonstration

JOHN B. DEVER—12 General surgical clinic

Thursday

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests

DR. HAMMETT—9 Chemistry of cell division

MRS. MCNETT—9 Exhibition of drawings of pathological specimens

MISS JASTROW—11 Exhibition of follow up service

ROBERT SHOEMAKER—11 X ray demonstration

JOHN B. DEVER—12 General surgical clinic

Friday

COLBY ENGEL—9 Injection treatment of varicose veins

STANLEY REIMANN and staff—9 Exhibit of pathological specimens and demonstration of laboratory tests

DR. HAMMETT—9 Chemistry of cell division

MRS. MCNETT—9 Exhibition of drawings of pathological specimens

MISS JASTROW—11 Exhibition of follow up service

ROBERT SHOEMAKER—11 X ray demonstration

WILLIAM MACKINNEY—3 Cystoscopy

## MT SINAI HOSPITAL

Monday

MOSES BEUREND—1 15 General surgical operations

Tuesday

BENJAMIN LIPSCHUTZ—9 General surgical operations

ALEXANDER RANDALL—2 30 Urological clinic, operations and demonstration of cases

Wednesday

CHARLES MAZER—9 Operative gynecology

MORRIS COOPERMAN—2 Orthopedic clinic, operations and demonstration of cases

Thursday

BERNARD MANN—9 Operative gynecology

ALEXANDER RANDALL—2 30 Urological clinic, operations and demonstration of cases

Friday

BENJAMIN LIPSCHUTZ—9 General surgical operations and demonstration of cases

MOSES BEUREND—1 General surgical operations and demonstration of cases

## PRELIMINARY CLINICAL PROGRAM

## GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

## TEMPLE UNIVERSITY HOSPITAL

## Monday

- WILLIAM A STEEL—1 Surgical operations  
 W HIRSEY THOMAS—3 Genito urinary surgery  
 TEMPLE FAY—3 Surgical treatment of epilepsy  
 EUGENE P PENDERGRAS—3 Surgical radiologic conference roentgenologic diagnosis of hypertrophied gastric mucosa and pedunculated tumors of the stomach prolapsing into the duodenum  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Tuesday

- TEMPLE FAY—9 Neurosurgical clinic encephalography  
 W WAYNE BARCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 HARRY HADSON—1 Orthopedic surgery  
 TEMPLE FAY—3 Management of traumatic injuries to the brain  
 EUGENE P PENDERGRAS—3 Surgical radiological conference roentgenologic diagnosis of liver abscess and subdiaphragmatic collections  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Wednesday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic spinal cord tumor cases  
 W WAYNE BARCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 WILLIAM A STEEL—11 General surgical operations  
 H Z HIRSHMAN—3 Atypical neuralgia and trigeminal neuralgia  
 EUGENE P PENDERGRAS—3 Surgical radiological conference roentgenologic study of the neck and upper respiratory tract  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Thursday

- TEMPLE FAY—9 Neurosurgical clinic cerebellar tumor cases  
 W WAYNE BARCOCK—10 General surgical operations  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 WILLIAM A STEEL—12 Baerger's clinic operative and ambulant cases  
 JESSE AROLD—1 Obstetrics  
 TEMPLE FAY—3 Neurosurgical clinic dehydration states normal in eclampsia and uremia and acute toxic states  
 EUGENE P PENDERGRAS—3 Surgical radiological conference  
 FRANK W KONZELMAN—4 Surgical pathological conference

## Friday

- WILLIAM N PARKINSON—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic gangliectomy or sympathectomy  
 W WAYNE BARCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND H DUNCAN and C S MILLER—11 Operative gynecology  
 WILLIAM A STEEL—11 Operative surgery  
 W HIRSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Neurosurgical clinic  
 EUGENE P PENDERGRAS—3 Surgical radiological conference encephalography  
 FRANK W KONZELMAN—4 Surgical pathological conference

## JEFFERSON HOSPITAL

## Tuesday

- I BROOKS BLAND and staff—9 Gynecology and obstetrics  
 J TORRANCE REICH and staff—10 Orthopedics  
 J CHALMERS DA COSTA and staff—11 General surgery  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 JOHN H GIBSON and staff—2 General surgery

## Wednesday

- BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 J CHALMERS DA COSTA and staff—11 General surgery

## Thursday

- P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—10 Genito urinary surgery  
 J CHALMERS DA COSTA and staff—11 General surgery  
 J TORRANCE REICH and staff—11 Orthopedic surgery  
 P BROOKE BLAND and staff—4 Obstetrics

## Friday

- BROOKE M ANSPACH and staff—9 Gynecology  
 P BROOKE BLAND and staff—9 Gynecology and obstetrics  
 THOMAS C STELLWAGEN and staff—11 Genito urinary surgery  
 JOHN H GIBSON—11 General surgery

## U S NAVAL HOSPITAL

## Tuesday

- Staff—9 Surgical operations

## Wednesday

- Staff—9 Surgical operations

## Thursday

- Staff—9 Surgical operations

## Friday

- Staff—2 Discussion of surgical cases or surgical topics

## GRADUATE HOSPITAL

*Monday*

- GEORGE F. PFAHLER—2 Radiation in diagnosis of malignant diseases  
 GEORGE PERSOL—2 Dry clinic Cardioresenal cases  
 ORLANDO PETTY—4 Demonstration of diabetes cases

*Tuesday*

- H. L. BOCKUS—9 Gastro intestinal diagnosis  
 WALTER F. LEE—9 General surgical clinic  
 B. A. THOMAS—2 Genito urinary operations

*Wednesday*

- JOHN P. JOHNSON—9 General surgery  
 H. L. BOCKUS—2 Gastro intestinal diagnosis  
 EUGENE A. CASE—2 Surgical pathology  
 GEORGE PERSOL—2 Dry clinic Cardioresenal cases

*Thursday*

- EUGENE A. CASE—2 Surgical pathology  
 C. F. MARTIN and W. O. HERMAN—9 Rectal infections

*Friday*

- J. B. CARNETT—9 General surgical clinic  
 B. A. THOMAS—2 Genito urinary operations  
 GEORGE PERSOL—2 Dry clinic Cardioresenal cases  
 GEORGE E. PFAHLER—2 Radiation in diagnosis and treatment of malignant diseases

## ST JOSEPH'S HOSPITAL

*Monday*

- FRANCIS J. McCULLOUGH—3 Obstetrical clinic

*Tuesday*

- MELVIN M. FRANKLIN—9 Fractures in children  
 F. HURST MAIER—10 Gynecological operations

*Wednesday*

- JAMES A. KELLY—9 General surgical clinic  
 JOHN F. A. JONES—9 General surgical clinic

*Thursday*

- ALEXANDER E. BURKE—8 Gynecological surgery  
 F. HURST MAIER—10 Gynecological surgery  
 CHARLES F. NASSAU—10 General surgery

*Friday*

- MELVIN M. FRANKLIN—9 Surgery of children  
 FRANCIS J. McCULLOUGH—3 Obstetrical clinic

## ST MARY'S HOSPITAL

*Tuesday*

- JAMES A. KELLY—9 General surgery  
 WILLIAM J. RYAN—9 General surgery  
 WILLIAM E. PARKE—1 Obstetrical clinic

*Wednesday*

- A. P. KEEGAN—9 General surgery  
 WILLIAM MORRISON—9 Gynecology

*Thursday*

- HENRY K. SEELAUS—9 General surgery  
 JOSEPH TOLAND—9 Gynecology  
 J. STUART LAWRENCE—1 Obstetrical clinic

*Friday*

- P. A. MCCARTHY—9 General surgery  
 LEO WOJCIANSKI—9 Gynecology

## MISERICORDIA HOSPITAL

*Tuesday*

- J. A. KELLY and B. R. BELTRAN—9 General surgical operations  
 F. MCGOVERO—11 Pre and postoperative care

*Wednesday*

- G. P. MULLER and T. RYAN—9 General surgical operations  
 DR. DOLGHERTY—11 Fractures of the femur

*Thursday*

- J. A. KELLY and B. R. BELTRAN—9 General surgical operations  
 J. A. SHARKEY and D. C. GEIST—11 Blood transfusion, operative results in fractures

*Friday*

- G. P. MULLER and T. RYAN—9 General surgical operations  
 J. B. CARDONE and E. J. GARVIN—11 General surgical clinic

## PHILADELPHIA GENERAL HOSPITAL

*Tuesday*

- M. P. WARMUTH—9 General surgery  
 FRANK C. HAMMOND—9 Gynecology and obstetrics

*Wednesday*

- J. T. RUGH—9 Orthopedics  
 HUBLEY OWEN—2 General surgery

*Thursday*

- JOHN O. BOWER—9 General surgery  
 J. A. SCHULMAN—9 Gynecology and obstetrics  
 WILLIAM H. MCKINNEY—2 Genito urinary surgery

*Friday*

- HARVEY M. RICHTER—9 General surgery  
 Staff—2 X-ray demonstration

## METHODIST EPISCOPAL HOSPITAL

*Tuesday*

- DAMON B. PFEIFFER and CALVIN M. SMYTH, JR.—9 General surgical operations

*Wednesday*

- JOHN C. HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
 JAMES H. BALDWIN—9 General surgical operations

*Thursday*

- GEORGE SCHWARTZ—9 General surgical operations

*Friday*

- DAMON B. PFEIFFER and CALVIN M. SMYTH, JR.—9 General surgical operations

## KENSINGTON HOSPITAL FOR WOMEN

*Tuesday*

- H. C. DEANER—12 General surgery

*Wednesday*

- WILLIAM E. PARKE—10 General surgery  
 JOHN B. HAINES—330 Cystoscopic clinic

*Friday*

- H. C. DEANER—12 General surgery



## ST. LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

## Tuesday

A. B. WEBSTER—9 Surgical clinic  
 WARREN C. MERCER and staff—9 Obstetrical clinic

## Wednesday

HERBERT P. LEOPOLD and staff—9 Surgical clinic  
 WILLIAM C. HUNSICKER and staff—9 Urological clinic

## Thursday

H. K. ROESSLER—9 Surgical clinic  
 RICHARD W. LARER, JOHN A. BROOKE and staff—9 Orthopedic clinic  
 JAMES D. SCHOFIELD and staff—9 Clinic on diseases of the rectum  
 WESTON D. BAYLEY and associates—2 Neurosurgical symposium on injuries of the head  
 FRANK C. BENSON and staff—2 Dry clinic. Indications and contra indications for use of radium in myopathic hemorrhage  
 G. MORRIS GOLDEN and group—2 Dry clinic and symposium on pre- and postoperative problems of toxic gut

## NORTHWESTERN GENERAL HOSPITAL

## Monday

J. S. RAUDENBUSH—2 Gynecology

## Tuesday

J. B. MENCKE, ROBERT BOYER and I. B. PARKER—9 General surgical operations  
 ARTHUR D. KURTZ—2 30 Orthopedic clinic

## Wednesday

J. B. MENCKE, ROBERT BOYER and I. B. PARKER—9 General surgical operations  
 J. S. RAUDENBUSH—12 Gynecology  
 L. C. DAVIS—3 Rectal clinic

## Thursday

J. B. MENCKE, ROBERT BOYER and I. B. PARKER—9 General surgical operations  
 L. I. MILLIKAN—2 30 Genito urinary surgery

## FRANKS HOSPITAL

## Wednesday

R. W. TEAHAN—2 Carcinoma of breast  
 C. A. WHITCOMB—2 Lung tumors  
 E. E. DOWNS—2 The saturation method of X-ray treatment  
 W. S. HASTINGS— Exhibition of interesting pathological specimens

## Thursday

R. W. TEAHAN—2 Carcinoma of skin  
 C. A. WHITCOMB—2 Mediastinal masses  
 E. E. DOWNS—2 Exhibition of interesting X-ray films  
 W. S. HASTINGS—2 Exhibition of interesting pathological specimens

## WOMAN'S HOMEOPATHIC HOSPITAL

## Tuesday

FRANCIS I. HUGHES—9 Gynecological clinic

## Wednesday

ARTHUR HARTLEY—9 General surgical clinic

## JEWISH HOSPITAL

## Tuesday

PHILIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
 RALPH GOLDSMITH—10 Fracture clinic  
 WILLIAM H. KELLER—2 General surgical operations

## Wednesday

IRVING B. BLOCK—9 General surgical operations  
 MOSES BEHREND—11 General surgical clinic  
 THOMAS STELLWAGEN and JOHN B. LOWES—2 Urological operations  
 LEON BRINMANN—2 General surgical operations

## Thursday

MOSES BEHREND—9 General surgical clinic moving pictures gastro enterological cases

## Friday

PHILIP WILLIAMS and E. SCHUMANN—9 Operative gynecology  
 RALPH GOLDSMITH—10 Fracture clinic  
 WILLIAM H. KELLER—2 General surgical operations

## PENNSYLVANIA HOSPITAL

## Tuesday

CHARLES I. MITCHELL and associates—9 Surgical clinic

## Wednesday

JOHN H. GIBSON and associates—9 Surgical clinic

## Thursday

CHARLES F. MITCHELL and associates—9 Surgical clinic

## Friday

JOHN H. GIBSON and associates—9 Surgical clinic

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## Tuesday

JOHN DEAN ELLIOTT, T. C. GEARY and THOMAS DOYLE—9 General surgical clinic  
 LEON F. ASHCRAFT—2 Urological surgery

## Wednesday

JOHN A. BROOKE—2 Orthopedic surgery

## Thursday

NATHANIEL F. LANE—2 Gynecological clinic  
 NEWELL F. PAXSON—2 Lipiodol study of fallopian tubes

## Friday

WARREN C. MERCER—2 Postnatal clinic

## CELANANTOWN HOSPITAL

## Wednesday

WILLIAM B. SWARTLEY—10 General surgery

## Friday

WILLIAM B. SWARTLEY—10 General surgery

## ST. CHRISTOPHER'S HOSPITAL

## Tuesday

Staff—10 General surgery

## Friday

R. L. JOHN—10 Orthopedics

## CHILDREN'S HOSPITAL

- WALTER F STELLER—11 Surgical clinic  
 WILLIAM A JAQUETTE—11 Dental clinic  
 HOWARD CHILDS CARPENTER—11 Preventive medicine in reference to surgical diseases in children  
 SUSAN C FRANCIS, R N—11 Hospital management from surgical viewpoint  
 J C GITTINGS—11 Medical aspect of surgical cases in children  
 RALPH S BROMER—11 Roentgenological aspect of children's diseases  
 EDWARD F CORSON—11 Bone syphilis and other allied surgical conditions  
 C C NORRIS—11 Vaginitis clinic

## WOMAN'S HOSPITAL

- Tuesday*  
 EMILY W ALGE—9 General surgery  
*Wednesday*  
 FAITH S LETTFRMAN—9 Cystoscopic demonstration  
*Thursday*  
 LIDA S COGILL—2 Obstetrical demonstration  
*Friday*  
 MARIE FORMAD—9 Gynecological clinic

## EVANS DENTAL INSTITUTE

- Tuesday*  
 ROBERT H IVY—9 Fracture of the jaw  
*Wednesday*  
 LAWRENCE CURTIS—9 Oral surgical clinic  
*Thursday*  
 ROBERT H IVY and LAWRENCE CURTIS—9 Oral surgical clinic

## NORTHEASTERN HOSPITAL

- Tuesday*  
 F C DAVIS—2 Proctology  
 T T THOMAS and J C SCOTT—3 Dry clinic, fractures and dislocations  
*Wednesday*  
 J B LOWNES—4 Genito urinary surgery  
*Thursday*  
 J S RAUDENBUSH—2 Gynecology and obstetrics  
 T T THOMAS—3 General surgery

## AMERICAN ONCOLOGIC HOSPITAL

- Tuesday*  
 ALBERT E BOTHE, CHARLES E CODMAN, GEORGE M DORRANCE, WILLIAM C HUEPER, BRADY A HUGHES, C B LONGENECKER, SAMUEL McCCLARY III, ELLICE McDONALD, WILLIAM S NEWCOMET, DAMON B PFETTER, WILLIAM D ROBINSON, JESSE W SMITH, WILLIAM H SPENCER and S E TRACY—9 Clinical conference with exhibition of patients. Fibroid tumors, breast cases, congenital mouth cases, heman gliomas, etc

## SUTTON HOSPITAL

- Monday*  
 CARL I KOENIG—130 X ray demonstration  
*Tuesday*  
 WILLIAM T ELLIS and JOHN A BOGER—12 General surgery  
*Wednesday*  
 STEPHEN F TRACY—830 Gynecology  
 CARL I KOENIG—130 X ray demonstration  
*Friday*  
 STEPHEN E TRACY—830 Gynecology  
 CARL I KOENIG—130 X ray demonstration

## CHESTNUT HILL HOSPITAL

- Tuesday*  
 JOHN MCCLOSKEY—1030 General surgical clinic  
 DRS SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics  
*Thursday*  
 CHARLES BENNEY—9 Operative gynecology  
 ALEXANDER RANDALL—9 Urological clinic  
*Friday*  
 W C SHEEHAN and L HERGESHEIMER—9 General surgery  
 DRS SCHUMANN, BARRETT and TOWSON—11 Operative obstetrics

## PENNSYLVANIA HOSPITAL

(Maternity Department and Lying In Hospital)

- Tuesday*  
 N W VAUX and staff—9 Obstetrics and gynecology  
*Wednesday*  
 C B PIPER and staff—9 Obstetrics and gynecology  
*Thursday*  
 N W VAUX and staff—9 Obstetrics and gynecology  
*Friday*  
 F B PIPER and staff—9 Obstetrics and gynecology

## FRANKFORD HOSPITAL

- Tuesday*  
 C F NASSAU, L D ENGLERTH and B CHANDLER—9 General surgery  
*Wednesday*  
 EDWARD SCHUMANN and FREDERICK KELLER—9 Gynecological clinic  
*Thursday*  
 W F PARKE—9 Gynecological clinic  
 GEORGE HANNA—9 Obstetrical clinic  
 L D ENGLERTH and B CHANDLER—2 Fracture clinic

## SURGERY OF THE EYE, EAR, NOSE AND THROAT

CLINICAL DEMONSTRATIONS  
(Ballroom Bellevue Stratford Hotel)*Tuesday, 9 a m*

Indications for and Technique of the Different Operations  
for Chronic Mastoiditis (lantern slide demonstration)

J MORRISSET SMITH M D New York  
Discussion J CLARENCE KEELER M D Philadelphia

Chronic Suppurative Otitis Media GEORGE L TOBEY  
M D Boston

Discussion GEORGE M COATES M D Philadelphia

What Place Have Operative Procedures in Otolology? JOHN  
I BARNHILL M D Indianapolis

Discussion GEORGE B WOOD M D Philadelphia

Preparation for Ophthalmic Practice EDWARD JACKSON  
M D Denver

Discussion T B HOLLOWAY M D Philadelphia

*Wednesday 9 a m*

Practical Application of Bacteriology to Clinical Ophthalmology  
S HANFORD MCKEE M D Montreal

Discussion JOHN A KOLMER M D Philadelphia

Cataract Extraction—A Study of Details WALTER B  
LANCASTER, M D Boston

Cataract Extraction (moving picture demonstration)  
IRVING LARKER M D Norristown Pa

Discussion EUGENE M BLAKE, M D New Haven  
Conn and LUTHER C PETER M D Philadelphia

Some Factors Concerned in the Success of Operations for  
Glaucoma JONAS FRIEDENWALD M D Baltimore

Discussion WILLIAM ZENTMEYER M D and FRANCIS  
H ADLER M D Philadelphia

*Thursday 9 a m*

Elastic Facial Work MILRAY P BLAIR M D St Louis

Discussion ROBERT H IVY, M D, Philadelphia

Rare Types of Carcinoma and Conditions Simulating  
Carcinoma (lantern slide demonstration) JOHN I  
MACKENTY M D New York

Early Diagnosis and Treatment of Malignancy of the  
Laryngopharynx HENRY BOYLAN ORTON, M D  
Newark NJ

Discussion FIELDING O LEWIS M D Philadelphia

Treatment of Tic Douloureux and Ménière's Disease  
WALTER E DANDY M D Baltimore

Discussion FRANCIS C GRANT M D Philadelphia

*Friday, 9 a m*

Symposium on Sinus Thrombosis

Rhinological Aspects E ROSS FAULKNER M D, New  
York

Otological Aspects WELLS F EAGLETON, M D, Newark,  
NJ

Ophthalmological Aspects W L BENEDECT, M D,  
Rochester, Minn

Neurosurgical Aspects PROFESSOR OTFRIED FORSTER,  
Breslau Germany

Discussion GEORGE M COATES M D, RALPH  
BUTLER, M D, Philadelphia, and PROFESSOR EMILE  
V GROSZ, Budapest, Hungary

## TEMPLE UNIVERSITY HOSPITAL

*Monday*

MATTHEW FRISNER—3 Operative otology

*Tuesday*

CHEVALIER JACKSON and associates—3 30 Bronchoscopic  
clinic

ROBERT RIMPATH—2 Laryngological clinic

LUTHER C PETER—3 Operative ophthalmology

*Wednesday*

CHEVALIER JACKSON and associates—3 30 Bronchoscopic  
clinic

*Thursday*

CHEVALIER JACKSON and associates—3 30 Bronchoscopic  
clinic

ROBERT RIMPATH—2 Operative laryngology

LUTHER C PETER—4 Ophthalmological surgery

*Friday*

CHEVALIER JACKSON—3 30 Bronchoscopic clinic

MATTHEW FRISNER—4 Otolological clinic

## MT SINAI HOSPITAL

*Monday*

C W LEFFLER—3 30 Eye clinic operations and demon-  
stration of cases

*Tuesday*

LEWIS FISHER—1 Ear nose and throat clinic operations  
and demonstration of cases

*Wednesday*

DAVID HUSK—2 30 Ear nose and throat clinic

GABRIEL TUCKER—4 Bronchoscopy

*Thursday*

MORRIS WEINSTEIN—2 Ear nose and throat clinic, opera-  
tions and demonstration of cases

*Friday*

MATTHEW FRISNER—1 Ear nose and throat clinic opera-  
tions and demonstration of cases

## HAINEMANN HOSPITAL

*Tuesday*

H S WEAVER and staff—2 Ear, nose and throat clinic

*Thursday*

H S WEAVER and staff—2 Ear nose and throat clinic

*Friday*

FRANK NAGLE and FRED PETER—9 Cataract operations

## FRANKFORD HOSPITAL

*Tuesday*

FRANK IMBRY and ROBERT WATT—2 Ear nose and  
throat clinic

*Wednesday*

WILLIAM H CHANDLER—2 Eye clinic

DR RICHARDSON—2 Ear nose and throat clinic

## ST CHRISTOPHER'S HOSPITAL

*Monday*

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

*Wednesday*

H J WILLIAMS or E H CAMPBELL—9 Nose and throat clinic

*Thursday*

DR FELDMAN—10 Eye clinic

*Friday*

H J WILLIAMS or E H CAMPBELL—1 30 Nose and throat clinic

## LANFAN HOSPITAL

*Monday*

W J CREIGHTON and DR SMITH—1 Eye clinic

*Tuesday*W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BABBITT—2 Ear, nose and throat clinic*Wednesday*

W J CREIGHTON and DR SMITH—1 Eye clinic

*Friday*W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BABBITT—2 Ear, nose and throat clinic

## GRADUATE HOSPITAL

*Monday*

R BUTLER, G M COATES, S R SKILLERN, G B WOOD and F B GLEASON—2 Ear, nose and throat clinic

*Tuesday*

R BUTLER, G M COATES, S R SKILLERN, G B WOOD and F B GLEASON—2 Ear, nose and throat clinic demonstration of cases of intercostal neuralgia

## PRESBYTERIAN HOSPITAL

*Monday*

H M LANGDON and J M THORINGTON—2 Ophthalmology

*Friday*

N P STAUFFER, W CARISS and O R KLINE—2 Otolaryngological operations

## JEWISH HOSPITAL

*Wednesday*

J C KATZ—3 Ophthalmological operations

*Thursday*

A S KAUFMAN and R F RIDPATH—2 Otolaryngological operations

## ST LUKE'S AND CHILDREN'S HOMOPATHIC HOSPITAL

*Tuesday*

CHARLES B HOLLIS and staff—9 Ear, nose and throat clinic

## EPISCOPAL HOSPITAL

*Monday*FREDERICK KRAUSS—2 Eye clinic  
W R WATSON—2 Ear, nose and throat clinic*Tuesday*

HAROLD VON GONDBERG—2 Eye clinic

*Wednesday*W R WATSON—1 30 Ear, nose and throat clinic  
A C HEWELL—3 Eye clinic*Thursday*C C BIDDERT—1 30 Ear, nose and throat clinic  
FREDERICK KRAUSS—1 30 Eye clinic*Friday*C C BIDDERT—1 30 Ear, nose and throat clinic  
HAROLD VON GONDBERG—1 30 Eye clinic

## ST JOSEPH'S HOSPITAL

*Tuesday*GEORGE MORLEY MARSHALL—9 The Marshall operation for nasal deformity with end results  
A J KEFNA—3 Otolaryngological operations*Wednesday*

ARTHUR WRICLEY—9 Otolaryngological operations

*Thursday*GEORGE MORLEY MARSHALL—9 The radical mastoid with end results  
C T MCCARTHY—2 Otolaryngological operations*Friday*

FRANCIS V GOWEN—9 Otolaryngological operations

## CHIFFINUT HILL HOSPITAL

*Tuesday*

JOHN R DAVIES—1 Ear, nose and throat clinic

*Wednesday*

BENJAMIN D PARISH—1 30 Ear, nose and throat clinic

*Thursday*JOHN R DAVIES—1 Ear, nose and throat clinic  
CARL WILLIAMS—2 Ophthalmology*Friday*

BENJAMIN PARISH—1 30 Ear, nose and throat clinic

## COOPER HOSPITAL

(Camden)

*Tuesday*

A M ELWELL—2 Otolaryngological operations

*Thursday*

A M ELWELL—2 Otolaryngological operations

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

*Thursday*

GILBERT J PALEN, CARROLL HAYNES, H BAILEY CHALFONT and EVERETT A TYLER—2 Tonsillectomy and adenoidectomy clinic, adults and children under gas anesthesia

## MISERICORDIA HOSPITAL

*Monday*

J E LOFTUS—2 Otolaryngological operations

*Tuesday*

C T MCCARTHY—2 Otolaryngological operations

*Wednesday*

J L LOFTUS—2 Otolaryngological operations

*Thursday*

C T MCCARTHY—2 Otolaryngological operations

*Friday*

J E LOFTUS—2 Otolaryngological operations

## UNIVERSITY HOSPITAL

*Wednesday*

GEORGE FETTEROLF and staff—2 Otolaryngological clinic operations and demonstration of cases

*Friday*

GEORGE FETTEROLF and staff—2 Otolaryngological clinic operations and demonstration of cases

T B HOLLOWAY—4 Ophthalmological clinic

## PHILADELPHIA GENERAL HOSPITAL

*Tuesday*

ROBERT J HUNTER—2 Laryngology

*Friday*

L WALLER DECHLER—9 Ophthalmology

## WILLS EYE HOSPITAL

STAFF—2 daily Ophthalmological clinics operations and demonstration of cases

## STULTSON HOSPITAL

*Thursday*

CARLE LEE FELT—12 Ear nose and throat clinic

## CHILDREN'S HOSPITAL

JAMES A BABBITT and associates Nose and throat clinic

EDWARD SHUMWAY Eye clinic

## WOMAN'S HOMEOPATHIC HOSPITAL

*Thursday*

JOSEPH V F CLAY J R CRISWELL and CHARLES J A FRIES JR—9 Nose and throat clinic

## JLILFLKSON HOSPITAL

*Tuesday*

LOUIS H CLERY and staff—9 Bronchoscopy

F O LEWIS and staff—9 Nose and throat operations

*Wednesday*

F O LEWIS and staff—10 Carcinoma of larynx

LOUIS H CLERY and staff—11 Bronchoscopy

*Thursday*

LOUIS H CLERY and staff—9 Bronchoscopy

F O LEWIS and staff—9 Nose and throat operations

*Friday*

C T G SHANNON and staff—3 Ophthalmology

## ST MARY'S HOSPITAL

*Tuesday*

WILLIAM GRADY—3 Otolaryngology

*Wednesday*

F A MURPHY—3 Ophthalmology

*Thursday*

R T M DONNELLY—3 Ophthalmology

EDWARD MURPHY—3 Otolaryngology

## NORTHWESTERN GENERAL HOSPITAL

*Tuesday*

M S ERSENER H S WIEDER and M A ZACKS—2 Nose and throat clinic

*Thursday*

M S ERSENER H S WIEDER and M A ZACKS—2 Nose and throat clinic

S H BROWN—3 Eye clinic

## ST ACNES HOSPITAL

*Tuesday*

BENJAMIN D PARISH—1 Ear nose and throat clinic

*Wednesday*

GEORGE F J KELLY—2 30 Ophthalmological clinic

## WOMAN'S MEDICAL COLLEGE HOSPITAL

*Tuesday*

MARGARET F BUTLER—1 Ear nose and throat clinic

*Friday*

MARGARET F BUTLER—2 Ear, nose and throat clinic

## NORTHEASTERN HOSPITAL

*Wednesday*

GEORGE F SHAFER—2 Sinus disease

C A LAWRENCE—3 Ophthalmology



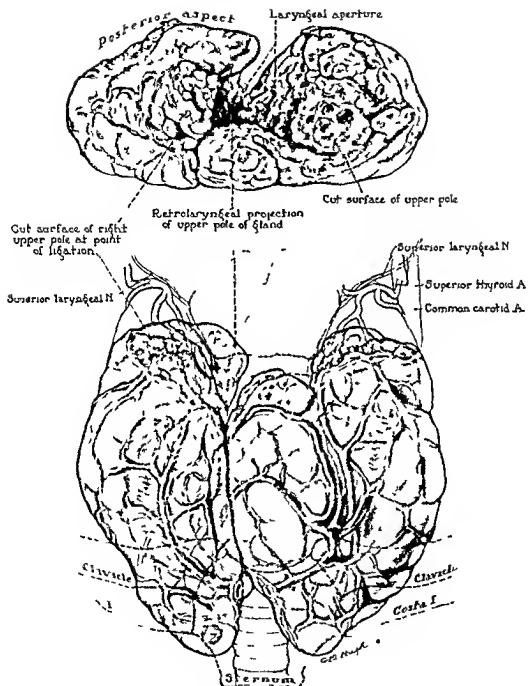


Fig 9 Specimen of a large goiter showing danger to the superior laryngeal nerve in thyroidectomy

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE LARYNX AS RELATED TO SURGERY OF THE THYROID BASED ON AN ANATOMICAL STUDY<sup>1</sup>

MARTIN NORDLAND, M.D., F.A.C.S., MINNEAPOLIS, MINNESOTA

From the Department of Anatomy, University of Minnesota

**I**N the study of the surgical anatomy of any organ, the relationship of that organ to adjacent structures is of primary significance. The most important organ in relation to the thyroid gland is the larynx. Although the larynx is usually considered in the domain of the laryngologist, I believe that the surgeon doing work upon the thyroid should be thoroughly familiar with the anatomy of the larynx, for such knowledge will assist him to determine more accurately pre-operative affections of the larynx and will enable him better to avoid operative injury to the larynx.

The larynx which is so intimately related to the thyroid gland, lies ventral to the fourth and fifth cervical vertebrae. The normal thyroid, from 20 to 30 grams in weight, is situated over the front and sides of the upper (second to fourth) tracheal cartilages and the lateral lobes extend upward on either side of the larynx. Pathological changes in the thyroid often displace and distort the trachea and the larynx, and the surgical treatment of these disorders occasionally injures the nerves of the larynx, thereby interfering with its function.

The dissections on the cadavers in this study were performed for two reasons. First, to determine the distribution and the relations of the superior laryngeal nerve, second, to determine whether there is a difference in the anatomical relations between the recur-

rent laryngeal nerve and the inferior thyroid artery on the right and on the left side.

The distribution of the superior laryngeal nerve was studied because of recent differences of opinion relative to the possibility that some of the fibers of the superior laryngeal nerve, other than the external branch, are motor in character. The relations of the superior laryngeal nerve were studied to determine the possibility of injury to the nerve in thyroid surgery. The conclusions from these observations might explain the occasional occurrence of changes in the voice in patients on whom only a simple ligature of one superior thyroid pole had been applied. Nothing was found in the literature with reference to injury to the superior laryngeal nerve in thyroid surgery, except in Kocher's writings.

The relations of the recurrent laryngeal nerve to the inferior thyroid artery were studied because descriptions of this relationship in classical textbooks of anatomy do not agree and because opinions of surgeons differ.

To determine the distribution of the laryngeal nerves, careful dissections were made on 19 larynges. To note the relations of the superior and recurrent laryngeal nerves, careful dissections were performed on 31 cadavers. This study was undertaken in the Department of Anatomy at the University of Minnesota. The accompanying drawings, with one

<sup>1</sup>Presented before the Minnesota Academy of Medicine, February 19, 1930.



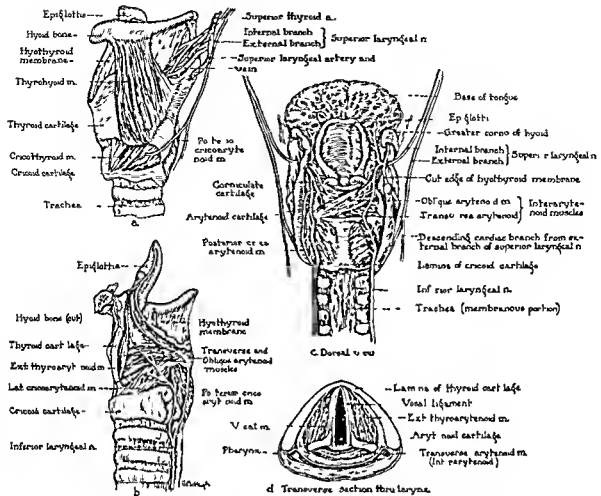


Fig 1 Dissection of the larynx to show the intrinsic muscles and distribution of the laryngeal nerves Note muscular distribution of internal branch of superior laryngeal nerve (Modified from Jackson)

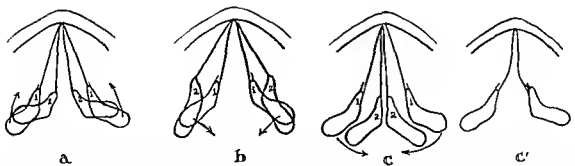


Fig 2 Action of the laryngeal muscles A Action of thyroarytenoids drawing arytenoid cartilage from position 1 to 2 B Action of posterior cricoarytenoids drawing arytenoid cartilages and vocal cords from 1 to 2 C Action of transverse arytenoid drawing vocal processes from 1 to 2 C' Position of vocal cords in paralysis of superior laryngeal nerve (Modified from Jackson)

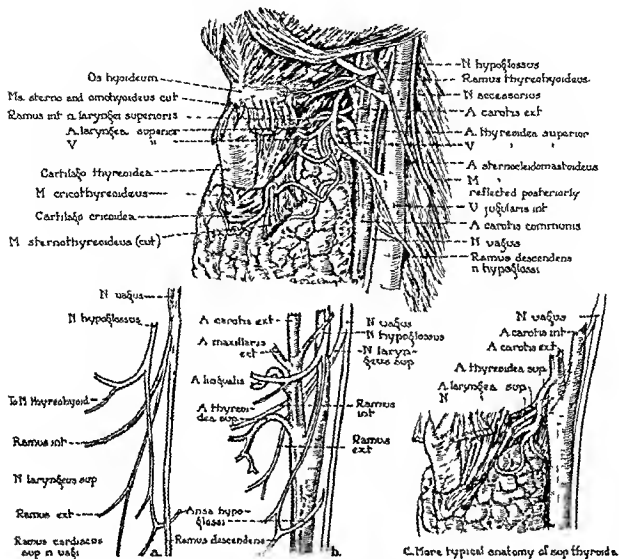


Fig. 3 Dissection to show the extralaryngeal relations of the superior laryngeal nerve to the thyroid

exception, were all made from our dissections. The anatomical findings, which have a surgical significance and which vary from the usual descriptions, will be the only features considered.

#### PREVIOUS STUDIES OF THE LARYNGEAL NERVES REPORTED IN THE LITERATURE

The innervation, both of the mucosa and of the muscles of the larynx has been frequently investigated. The usual teaching in anatomy and laryngology today is that the superior laryngeal nerve is sensory to the mucous membrane of the larynx through its internal branch, and motor only to the cricothyroid muscle through its external branch, and that the recurrent laryngeal nerves are motor to the remainder of the larynx. Dikworth, New,

Mullin, and Berlin and Lahey have taken exception to this opinion. New states that it seems probable that the adducted position assumed by the cords in cases of complete paralysis of the recurrent laryngeal nerve is due to the action of the muscles of the larynx which are supplied by the superior laryngeal nerve. Mullin states that the interarytenoid muscle, adductor of the cords, is innervated by motor fibers from the internal branch of the superior laryngeal nerve. Berlin and Lahey report the dissection of 12 larynges, in which they found in the naked eye dissections that the interarytenoid muscle was supplied exclusively by the internal branch of the superior laryngeal nerve in 10 of their dissections, while in the 2 others, this muscle received its nerve supply from both the superior

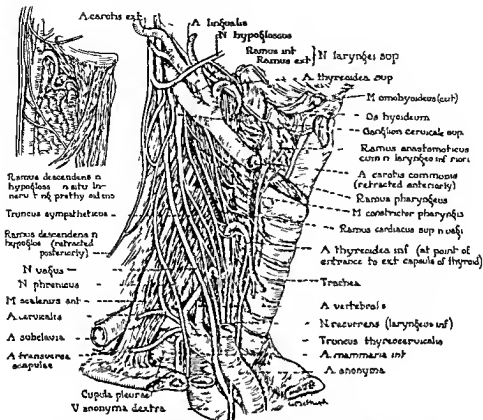


Fig. 4. Dissection of the right side of the neck to show relations of the superior and recurrent laryngeal nerves

and recurrent laryngeal nerves. In this study they further report a living case in which the vocal cords assumed the adducted (approximated) position, even after complete division of the right recurrent laryngeal nerve (supposed adductor of the cords). This clinical case indicated to them that there were motor fibers in the internal branch of the superior laryngeal nerve, innervating the interarytenoid muscle.

Lahey also studied the relations of the recurrent laryngeal nerves. On 22 cadavers, he found the recurrent laryngeal nerve more often anterior to the inferior thyroid artery on the right and posterior to the artery on the left side of the neck. De Quervain states that the recurrent laryngeal nerve penetrates the thyroid space a little farther from the trachea on the right than on the left and runs more often anterior to the artery and its branches on the right and generally posterior on the left. Contrary to these opinions the classical textbooks

of anatomy reveal the following. Gray states that the recurrent laryngeal nerve generally passes posterior to the inferior thyroid artery. Davis, in his *Applied Anatomy*, expresses the same opinion. Cunningham states that the nerve may go anterior or posterior to the inferior thyroid artery without stating any difference in the two sides. Morris Jackson states that after the recurrent laryngeal nerves reach the thyroid space, their relations are the same on the right and left side.

#### THE MUSCULATURE AND INNERVATION OF THE LARYNX

Before proceeding to the discussion of our findings in this study, the musculature and innervation of the larynx will be briefly reviewed.

The muscles of the larynx are divided into the extrinsic and the intrinsic groups. The extrinsic group which comes from neighboring parts to be inserted on the larynx (acting on

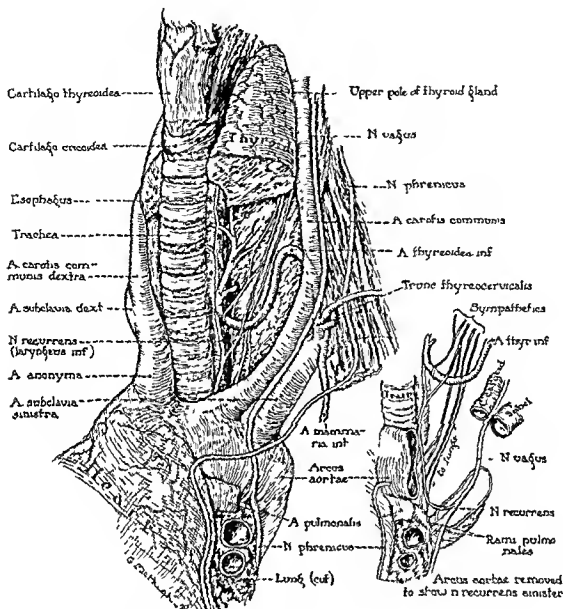


Fig. 5 Dissection of the left side of the neck to show the anatomical relations of the left recurrent laryngeal nerve

the voice box as a whole), will not be considered. The intrinsic muscles confine themselves strictly to the larynx and control the functions of phonation and respiration, in which we are interested. The intrinsic muscles of the larynx are (1) the posterior crico-arytenoids, (2) the lateral crico-arytenoids, (3) the thyro-arytenoids, (4) the interarytenoid, and (5) the cricothyroids. These muscles are supplied by the laryngeal branches of the vagus nerve (Fig. 1).

**Respiration** is brought about by the adductor muscles, and during respiration the vocal cords are held apart. This is controlled

by the paired posterior crico-arytenoids. These are the only true abductors of the cords. They arise from the posterior surface of the cricoid lamina. The fibers (oblique and longitudinal) insert on the muscular process of the arytenoid cartilages. When these muscles contract, the vocal cords are separated.

**Phonation** is brought about by the adductor or constrictor muscles of the vocal cords. These muscles, when contracting, approximate the cords in the midline (Fig. 2). In accomplishing this action, the lateral crico-arytenoids, which antagonize the posterior

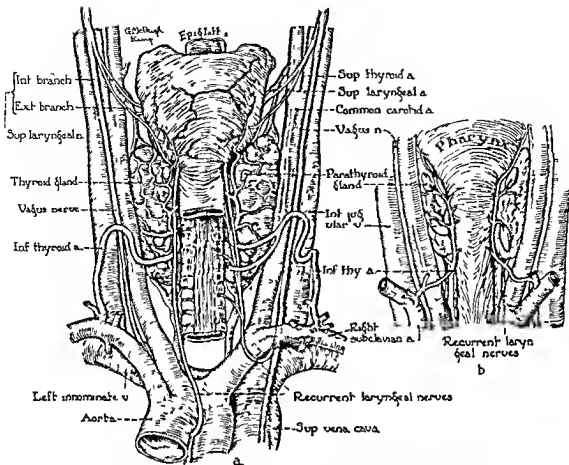


Fig 6 Posterior view of the larynx and trachea to show the anatomical relations of the laryngeal nerves to the thyroid arteries. A Accurate from dissections, B inaccurate (as found in many anatomical and surgical texts)

crico arytenoids, and the thyro arytenoids, which antagonize the cricothyroid, approximate the anterior one half of the vocal cords. The posterior portions of the cords are approximated by the interarytenoid muscle. This muscle lies in the posterior aspect of the larynx and crosses the space between the arytenoid cartilages. The cricothyroid muscles are composed of two distinct sets of fibers, vertical and oblique. As their name indicates, they control the change of position of the cricoid and thyroid cartilages and when in action lengthen and tense the vocal cords. The last two muscles described are particularly important in this study because of the danger to their nerve supply in the surgery of the thyroid.

#### RESULTS OF OUR STUDY

In our study of the distribution of the superior laryngeal nerve, we found in the dissection of 19 larynges that the interarytenoid muscle was exclusively innervated by the internal branches of the superior laryngeal nerves in 18 specimens. In only one specimen, the interarytenoid muscle received branches from both the internal branch of the superior and recurrent laryngeal nerves. An anastomotic twig between the internal branch of the superior laryngeal and recurrent laryngeal was present in 3 specimens.

Because the interarytenoid muscle is apparently innervated by the superior laryngeal nerve, the possibility of injury to this nerve in thyroid surgery becomes more important. The

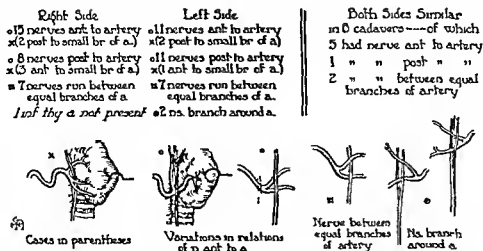


Fig. 7 Summary of the relations of the inferior thyroid artery to the recurrent laryngeal nerve in 31 cadavers studied

dissection to determine the relations of the superior laryngeal nerve shows that the nerve arises from the ganglion nodosum of the vagus (Fig. 3), and, after a short course, divides into two branches, a small external and a large internal branch. The external branch passes downward and mesialward and is finally distributed mainly to the cricothyroid muscle, which is described (Exner, quoted by Jackson-Coates, states that some of the fibers are distributed to the other constrictors of the larynx). The internal branch passes medially and enters the larynx through the thyrohyoid membrane. It is distributed to the mucus membrane of the larynx, and, as has been shown, to the interarytenoid muscle already described. It occasionally gives off an anastomotic branch to the recurrent laryngeal nerve. The superior laryngeal nerve from its origin lies parallel to and in close proximity with the superior thyroid artery and its branches. The surgical importance of this fact will be referred to later.

Our dissection further shows that the recurrent laryngeals arise from the vagus at different levels on the two sides, on the right (Fig. 4) as the vagus crosses the subclavian artery, on the left (Fig. 5) as the vagus crosses the arch of the aorta. Both the recurrent laryngeal nerves ascend a little lateral to the groove between the œsophagus and enter the larynx at the cricothyroid articulation. A posterior view (Fig. 6) of the larynx and trachea will show the relationship of the in-

ferior thyroid arteries and recurrent laryngeal nerves on both sides, the nerve a little farther from the tracheo-œsophageal groove than usually described. The figure on the left illustrates the positions of these structures, noting particularly the course of the inferior thyroid artery. On the right side of this figure is a reproduction of an illustration which appears frequently in textbooks on anatomy and surgery. The anatomy thus depicted, is misleading, since it does not correspond to the actual anatomy nor to the usual descriptions of the course taken by the inferior thyroid arteries.

The accompanying table (Fig. 7), is a summary of the relations of the inferior thyroid artery to the recurrent laryngeal nerve in the 31 cadavers studied. Our observations clearly indicate that there are no definite differences in the relations between the inferior thyroid artery and the recurrent laryngeal nerves on the right and left side, and, therefore, do not agree with the findings of Berlin and Lahey.

#### THE SURGICAL SIGNIFICANCE OF OUR FINDINGS

The discussion of the surgical application of these findings in thyroid surgery, will be limited mainly to hæmostasis, because in the surgical treatment of the diseased thyroid gland, injury to the laryngeal nerves occurs probably most often in the attempt to ligature the thyroid arteries and in the control of hæmorrhage within the capsule. Very little reference is made in the literature to the injury

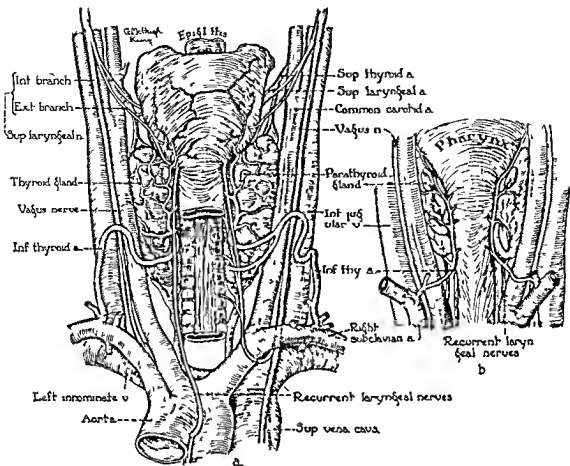


Fig 6 Posterior view of the larynx and trachea to show the anatomical relations of the laryngeal nerves to the thyroid arteries A Accurate from dissections B inaccurate (as found in many anatomical and surgical texts)

crico arytenoids, and the thyro arytenoids, which antagonize the cricothyroid, approximate the anterior one half of the vocal cords. The posterior portions of the cords are approximated by the interarytenoid muscle. This muscle lies in the posterior aspect of the larynx and crosses the space between the arytenoid cartilages. The cricothyroid muscles are composed of two distinct sets of fibers, vertical and oblique. As their name indicates, they control the change of position of the cricoid and thyroid cartilages and when in action lengthen and tense the vocal cords. The last two muscles described are particularly important in this study because of the danger to their nerve supply in the surgery of the thyroid.

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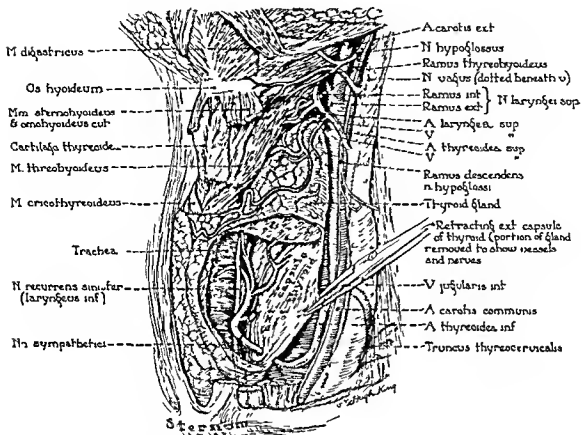


Fig 10 Dissections of the neck, left side to show the relations of the laryngeal nerves, thyroid arteries and capsule of the gland

trunk of the artery, but more often to one of its branches, not only endangering the recurrent laryngeal nerve, but also producing less hæmorrhage. The extrafascial approach for the ligation of the inferior thyroid artery, devised by de Quervain and adopted by us, is also indicated in this figure. In this method, the artery is tied at a point much farther from the gland, thereby more accurately preserving the nerve and giving more complete hæmorrhage. The nerve is further preserved by avoidance of postoperative hæmorrhages and hæmatoma which might press on the nerve.

#### CLINICAL SIGNIFICANCE

According to Reinhoff, pre-operative affections of the laryngeal nerves occur in from 5 to 10 per cent of cases of simple and toxic goiters, whereas, in malignant goiters the incidence is much higher. The percentage of operative injuries to the recurrent laryngeal nerves varies from 1 to 5 per cent and depends to a great extent on the type of the case and the technique employed, as previously in-

dicated. For instance, injury to the recurrent laryngeal nerve may be sustained during the mere delivery of a substernal enlargement of the left lobe, because the left recurrent nerve curves over the arch of the aorta. Thus, in a series of cases of this type, there would probably be a much higher incidence of injury to the recurrent laryngeal nerve than in the ordinary cases. The more care used in hæmorrhage, the less danger there is of paresis of the recurrences. Our dissections would indicate that the nerve would be more liable to injury by the intrafascial method of ligation of the artery. According to de Quervain, injuries to the laryngeal nerves are more frequent in thyroid surgery when the gland has been previously operated upon.

Phonation, which is accomplished by the approximation or adduction of the vocal cords, is brought about, as previously described, by the constrictor muscles of the larynx. Because the interarytenoid muscle (one of this group) is supplied by the internal branch of the superior laryngeal nerve, and because the



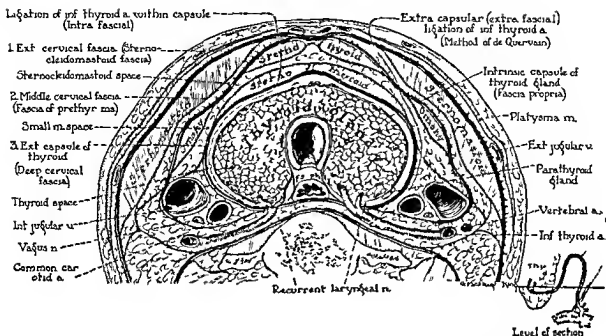


Fig. 11 Transverse section of the neck viewed from below to illustrate clinical application of ligatures to the inferior thyroid artery based on the anatomical relations

cricothyroid muscle is supplied by the external branch of the superior laryngeal nerve, it would seem from our study that an accident to the superior laryngeal, either at its trunk or to its branches, might easily explain many of the postoperative disturbances to the voice. Paralysis of the interarytenoid muscle, according to Jackson Coates, would cause a more or less complete aphonia, and a laryngoscopic examination would show on phonation the vocal cords in contact in their anterior three fourths, with an open triangular space posteriorly (Fig. 2 C<sub>1</sub>). The front portions of the cords are brought together by the crico arytenoid lateralis and the thyro arytenoids. Paralysis of the cricothyroid muscles innervated by the external branch of the superior laryngeal nerve, according to Jackson Coates, would cause the voice to become weak and rough and easily fatigued. Laryngoscopic examination would show the cords to have a wavy outline and a flap, owing to the loss of tension. If unilateral, the paralyzed cord lies at a lower level than the normal cord.

According to Judd recovery of the voice usually occurs following injuries to the laryn-

geal nerves and dyspnoea also disappears because the normally functioning cord overcompensates and approximates the affected one. Thus, the voice is restored, but usually in a lower pitch. It is probable that the percentage of injuries to the laryngeal nerves following surgery of the thyroid gland is higher than statistics show. Unless routine laryngoscopic examinations are made before and after operative procedure, one cannot be certain of the state of the function of the vocal cords. Such examinations should not be omitted.

#### SUMMARY

In conclusion, since Kocher called attention to the possibility of injury to the superior laryngeal nerve in thyroid surgery, and since other observers' findings and our findings point to the fact that the interarytenoid muscle is supplied by the internal branch of the superior laryngeal nerve, and since our dissections indicate that it is easy to injure the superior laryngeal nerve in the ligature of the superior thyroid artery, it is reasonable to conclude that postoperative disturbance to the voice may occur from injury to this nerve.

in thyroid surgery Further, because the recurrent laryngeal nerves occur anterior to the inferior thyroid arteries just as frequently on both sides, and because they penetrate the thyroid space a little farther from the tracheo-oesophageal groove than is usually described, therefore, to avoid injury to these nerves, extrafascial ligation of the inferior thyroid artery, according to de Quervain, is more reasonable when ligation of this artery is contemplated

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## A STUDY OF THE TENDON SHEATHS OF THE FOOT AND THEIR RELATION TO INFECTION<sup>1</sup>

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IN a previous study (Grodinsky, 1929), eleven fascial spaces were demonstrated in the foot and leg by dissection and injection methods, similar to those used by Kanavel (1921) in his studies of the hand. Since the present study is directly correlated to the previous one, a brief resume of the latter seems desirable.

There were found to be four median plantar spaces which for convenience have been designated as M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub>, and M<sub>4</sub>, beginning at the surface. M<sub>1</sub> lies between the plantar aponeurosis and the flexor digitorum brevis muscle, M<sub>2</sub> between the flexor brevis and quadratus plantæ, M<sub>3</sub> between the quadratus plantæ and the tarsal and metatarsal bones, and M<sub>4</sub> deep to the adductor hallucis obliquus. The other plantar spaces are a lateral space deep to the abductor digiti quinti, a medial space deep to the abductor hallucis and spaces along the lumbrical muscles. There are two dorsal foot spaces: subcutaneous and subaponeurotic. Finally there is a medial leg space between the superficial and deep calf muscles brought into relation with the foot by long flexor tendons behind the medial malleolus, and a lateral leg space deep to the fascial sheaths of the peronei, the tendons of which extend behind the lateral malleolus toward the foot. The boundaries of these spaces and the routes of spread from one to the other were determined, and incisions for draining them suggested.

The present study is an application of the same methods to the tendon sheaths. Careful dissections of fresh and preserved human material were made to determine the course and extent of the various tendon sheaths which have been described by Ponier and Rouviere (1912), and others. Further, these sheaths have been injected with paraffin or gelatin to outline them better and particularly to determine the routes of spread after rupture.

### DISSECTIONS

There are five groups of tendon sheaths in or related to the foot: the sheaths of the flexor tendons of the toes, the sheaths about the long flexors behind the medial malleolus, those about the peroneal tendons behind the lateral malleolus, the sheath about the peroneus longus tendon in the depths of the foot, and finally the sheaths of the extensor tendons on the dorsum of the foot and ankle (Figs. 1, 2).

*Sheaths of the flexor tendons of the toes.* Careful dissections of fresh and preserved human material show the distal limits of the sheath of the flexor hallucis longus tendon to be at or very close to the end of the tendon, in other words at the proximal end of the distal phalanx just beyond the interphalangeal joint. The proximal extent of the sheath is found to be from 1½ to 2 centimeters proximal to the prominent part of the head of the first metatarsal bone. This corresponds to the neck of the bone or even to a point somewhat proximal to the neck (¼ centimeter). As in the hand, the serous sheath is bound down to the sides of the phalanges and head of the metatarsal bone by a surrounding fibrous sheath which stops short of the proximal end of the serous sac leaving a small portion (½ to 1 centimeter) of the latter unprotected and more susceptible to perforation.

The short and long tendons of the second, third, fourth, and fifth toes are surrounded by common serous sheaths which extend distally almost to the insertions of the four long flexors of these toes on the proximal ends of the terminal phalanges, just beyond the distal interphalangeal joints. Their extension in the opposite direction is from 1 to 1½ centimeters proximal to the heads of the metatarsal bones or just about at the necks of these bones. Here again the serous sheaths are bound down and protected by surrounding fibrous sheaths except at their proximal ends where they remain exposed for about ½ to 1 centimeter.

<sup>1</sup>Reviewed before Nebraska Sectional Meeting of the American College of Surgeons, Omaha, February 4, 1930.

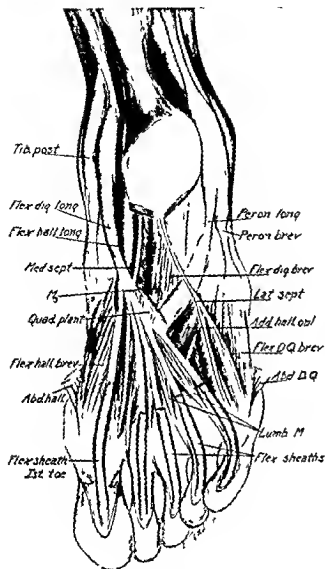


Fig 1 Plantar view of human foot and ankle showing serous sheaths of flexor and peroneal tendons

*Sheaths about the long flexors behind the medial malleolus* The proximal end of the sheath of the flexor hallucis longus tendon lies from  $\frac{1}{2}$  to 2 centimeters above the tip of the medial malleolus. This is about at the level of the upper border of the malleolus. The distal end extends just beyond the crossing of this tendon by that of the flexor digitorum longus muscle and is between 5 and 6 centimeters antero-inferior to the tip of the medial malleolus. In about half of the specimens there was a communication between this sheath and that of the flexor digitorum longus at their point of crossing in the foot. Porier and Rouviere (1912) found this communication in two of seven specimens.

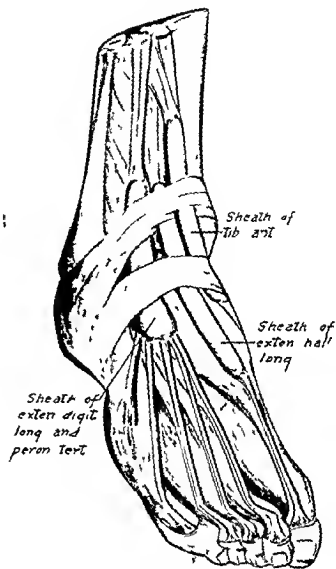


Fig 2 Dorsolateral view of human foot and ankle, showing serous sheaths of extensor tendons

The tendon of the flexor digitorum longus muscle lies anterior and superficial to that of the flexor hallucis longus. Its sheath extends from the upper border of the medial malleolus (2 centimeters above the tip) to the point where it crosses the tendon of the flexor hallucis longus in the foot. The latter point lies about 4 to 5 centimeters antero-inferior to the point of the medial malleolus. As stated above there is normal communication in about half the cases between the tendon sheaths of the flexor digitorum longus and flexor hallucis longus at this crossing. In one specimen there was also a communication between the sheaths of the flexor digitorum longus and tibialis posterior at their proximal extremities.

The tendon of the tibialis posterior muscle is the most anterior of the three tendons behind the medial malleolus (having been crossed over by that of the flexor digitorum longus in the lower third of the leg). The proximal end of its sheath lies 3 to 5 centimeters above the tip of the medial malleolus (3 centimeters in six of nine specimens). It extends distally almost to the insertion of the tendon on the tubercle of the navicular bone ( $1\frac{1}{2}$  to 3 centimeters antero inferior to tip of medial malleolus). It occasionally communicates with sheath of flexor digitorum longus at upper extremity (one specimen).

*Malleolar sheaths of the peroneus longus and brevis*—These tendons have a common serous sheath which branches distally into two divisions, one for each tendon. The proximal end of the common sheath lies from 3 to 6 centimeters above the tip of the lateral malleolus. Distally, the brevis division (which lies anterior to the longus) of the sheath extends a variable distance toward the insertion of the tendon on the base of the fifth metatarsal bone. In half the specimens, it extended to or almost to the insertion, and in the other half it extended to a point about midway between the tip of the malleolus and the insertion. Distally the longus sheath ends obliquely, extending farther into the foot on the deep side than on the superficial side. Superficially it ends where the tendon bends sharply to enter the foot. This point is 2 to 3 centimeters posterior to the base of the fifth metatarsal bone, or 3 to 4 centimeters antero inferior to the tip of the lateral malleolus. There is an occasional communication between the malleolar and plantar sheaths of the peroneus longus tendon (one in seven). Porier and Rouviere (1912) state that this communication is frequent.

*Plantar sheath of the peroneus longus*—The proximal portion of this sheath was in contact on its deep side with the distal end of the malleolar sheath of the peroneus longus tendon in three of seven specimens. In the remaining specimens the distance between the deep portions of the sheaths varied from  $\frac{3}{4}$  to 1 centimeter. In one case there was a communication between the sheaths. Distally the plantar sheath extends almost to the in-

sertion of the tendon on the first cuneiform and the base of the first metatarsal bone. The serous sheath is inclosed in an incomplete fibrous sheath derived from the long plantar ligament and tibialis posterior tendon. It is crossed by the lateral connective tissue boundary of the median plantar spaces.

*Extensor tendon sheaths*—The tendon sheath of the extensor hallucis longus muscle extends proximally 1 to 2 centimeters above the line joining the tips of the malleoli. Distally it ends 4 to 6 centimeters below this line. This point is opposite or a little proximal to the base of the fifth metatarsal bone. The sheath of the extensor digitorum longus tendon ends proximally  $1\frac{1}{2}$  to 3 centimeters above the intermalleolar line and distally 3 to  $4\frac{1}{2}$  centimeters below this line. The latter point is 2 to 4 centimeters above the base of the fifth metatarsal bone. The sheath of the tibialis anterior tendon extends the farthest proximally of any of the sheaths of the extensor tendons, 4 to  $5\frac{1}{2}$  centimeters above the intermalleolar line. Distally it ends  $1\frac{1}{2}$  to 5 centimeters below this line.

#### INJECTION EXPERIMENTS

In a series of sixty-four injections, two types of material were used: paraffin colored with sudan III and gelatin colored with india ink, the latter being the most satisfactory. Both fresh and preserved human material were used with similar results. The injections were made with a Luer syringe and needle, the pressure being controlled by the volume used. All were made through the unbroken skin to minimize leakage around the needle but, in some specimens, the sheath was first exposed a little distance away from the proposed point of puncture to insure its injection. In some cases, the masses were confined within the sheaths injected, thus confirming their outline and extent as determined by simple dissection. In others, sufficient pressure was used to rupture them, the masses spreading into adjacent tendon sheaths, or fascial spaces, or both. This was done to determine the possible routes of extension from the tendon sheaths in cases of infection of these sheaths.

*Extension from the sheath of the flexor tendon of the great toe*—This sheath was found to be

very strong and was ruptured in only one-third of the cases injected, the mass in the remaining specimens being confined within the sheath (Fig 3). About 3 to 4 cubic centimeters of solution were necessary to fill the sheath completely and the rupture occurred upon injecting an additional amount under increasing resistance. In every case that ruptured, the break occurred at the proximal end where the serous sheath loses its protective fibrous covering. The mass extended a variable distance proximally along the tendon of the flexor hallucis longus, in some cases beyond the point of crossing by the flexor digitorum longus and under the medial annular ligament into the medial leg space. In some, sufficient volumes were used to extend through the medial plantar septum into the median plantar spaces (M2 and M3).

An infection starting in the sheath of the flexor tendon of the great toe will therefore probably remain localized within that sheath until a sufficiently high pressure is attained to rupture it. When the break occurs, it will almost surely be at the proximal end with extension of the infection along the tendon toward the medial side of the ankle and the medial leg space, or into the median plantar spaces M2 and M3, or in both directions.

*Extension from the sheaths of the flexor tendons of the second, third, fourth, and fifth toes.* It required about 2 to 3 cubic centimeters of solution to fill each of these sheaths completely. With larger volumes there was increasing resistance and finally rupture and loss of the resistance (Figs 4, 5). In all but one specimen the rupture occurred proximally, demonstrating that as in the case of the great toe, the proximal end, unprotected by the fibrous outer sheath, is the weakest point. The single exception was in an injection of the fifth toe which was confined for the most part to the sheath but which had broken through one small area on the plantar surface over the second phalanx. In every case of rupture, the spread was into one or more of the median plantar spaces, M1, M2 and M3 (above described). The extension was into M1 in 85 per cent, into M2 in 85 per cent, into M3 in 92 per cent, and into all three in 77 per cent. The spread into M1 was con-

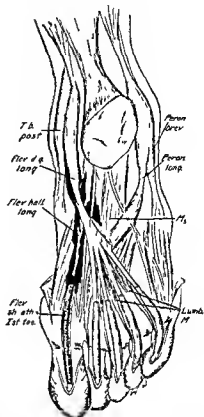


Fig 3. Plantar view showing spread of injection mass from ruptured serous sheath of long flexor tendon of great toe.

fined in many specimens to the compartments adjacent to the tendon concerned but in some (where a greater volume was used) the entire space was filled. M2 and M3 were more or less completely filled depending upon the volume used. Where the median plantar spaces were completely filled, the commonest extensions from M1 were subcutaneously medially and laterally, and along the digital nerves into the subcutaneous interspaces. From M2 the usual breaks were into the lumbrical spaces and through the medial wall around the crossing of the long flexor tendons or along the plantar structures (nerves and vessels). M3 also commonly ruptured through the medial wall to the crossing of the long flexors and to the medial side of the calcaneus. The other common spreads from M3 were into the lumbrical spaces, M4, and the dorsal subaponeurotic space. In addition it must be remembered that extensions from M1 to M2, M2 to M3, and vice versa are very common, so that no doubt in these specimens the spaces were sometimes filled by extension from adjacent spaces as well as directly from the

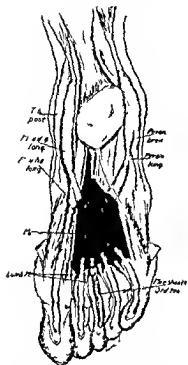


Fig 4. Plantar view showing spread of injection mass from ruptured serous sheath of flexor tendons of third toe

tendon sheaths. These extensions correspond almost identically with those determined in my previous study on the fascial spaces (1929).

These injections prove, I think, that when sheaths of the second, third, fourth and fifth toes rupture they do so proximally and that in over 75 per cent of the cases all the median plantar spaces are involved with the usual spread from these spaces secondarily. These sheaths, when infected, will probably likewise rupture proximally with extension of the infection into one or more of the median plantar spaces  $M_1$ ,  $M_2$ , and  $M_3$ .

*Extension from the malleolar sheath of the flexor hallucis longus tendon.* In almost every case where the sheath ruptured, the break occurred at either the proximal or distal end or both, the first and last being the most common (Fig 6). Probably this was due to the fact that the rest of the sheath had the protection of the annular ligament as well as the fibrous walls of the canal through which the tendon passed, deep to that ligament. Proximally the mass extended a variable distance

into the medial leg space, being either confined to the lateral side of that space within the fascial sheath of the flexor hallucis longus muscle, or rupturing through and spreading over the entire space between the superficial and deep calf muscles. Distally the mass extended around the crossing of the long flexors and a variable distance along the tendon of the flexor hallucis longus, even so far as to surround the distal sheath of that tendon (flexor sheath of the great toe). In some cases, in the region of the crossing of the long flexors, the mass broke through the medial wall of the median plantar spaces into  $M_2$  and  $M_3$ . The extensions from the proximal and distal extremities of the sheaths were therefore similar to those from the injections made outside these sheaths as described in the previous paper (Grodinsky, 1929). In about 50 per cent the mass had passed into the sheath of the flexor digitorum longus, apparently through a normal communication at their crossing.

It is probable, therefore, that an infection starting in the sheath of the flexor hallucis longus tendon will extend, provided the sheath ruptures, into the medial leg space, into the other sheaths behind the medial malleolus, along the tendon into the great toe, or finally, into the median plantar spaces, in the order named.

*Extension from the malleolar sheath of the flexor digitorum longus tendon.* In the cases in which this sheath ruptured, the proximal end was involved in every case and both ends in about 20 per cent (Fig 7). In no case did the rupture occur through the body of the sheath which was protected by the annular ligament. The extension proximally was into the medial leg space, being confined within the fascial sheath of the muscle in some cases and spread over the entire space in others. The distal extension was around the crossing of the long flexors, along the flexor hallucis longus tendon toward the great toe and through the medial wall of  $M_2$  and  $M_3$  into those spaces. These extensions were again similar to those from injections made outside the tendon sheath as described in the previous paper (Grodinsky, 1929). In 30 per cent, the mass had entered the tendon sheath of the flexor hallucis longus

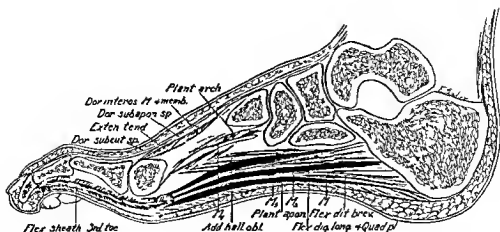


Fig 5 Sagittal section through third toe showing spread of injection mass from ruptured serous sheath of its flexor tendons

at the point of crossing, apparently through a normal communication. In a few cases, the injection had entered the tibialis posterior tendon sheath through a normal communication or a break at the upper extremities of the sheaths. In one instance, there was also evidence of a communication between these two sheaths at the lower border of the malleolus.

An infection starting in the tendon sheath of the flexor digitorum longus will therefore probably spread, provided the sheath ruptures, into the medial leg space, into the other sheaths behind the medial malleolus, to the crossing of the long flexor tendons, along the flexor hallucis longus tendon toward the great toe and into the median plantar spaces M<sub>2</sub> and M<sub>3</sub>, in the order named.

*Extension from the malleolar sheath of the tibialis posterior tendon.* Here the rupture occurred at both extremities with equal frequency (Fig 6). The rest of the sheath, protected by the annular ligament, did not rupture in any case. The extension proximally was into the medial leg space for a variable distance, again being confined within the fascial sheath of the muscle in some instances, and spreading over the entire space in others. Distally the spread occurred subaponeurotically and subcutaneously over the dorsum and medial side of the foot. In one case the mass spread over the crossing of the long flexors and broke through the medial wall of M<sub>2</sub> into that space. There were no communications with the other sheaths behind the malleolus in this series.

An infection starting in the sheath of the tibialis posterior tendon will probably spread, provided the sheath ruptures, to the medial leg space and over the medial side and dorsum of the foot.

*Extension from the malleolar sheath of the peroneus longus and brevis tendons.* Again the rupture usually occurred at the extremities, where the sheath was unprotected by the annular ligament (Fig 6). By far the most frequent point of rupture was at the proximal end, with a spread into the lateral leg space deep to the fascial sheaths of the peronei. The brevis division of the distal extremity ruptured in a few cases with a subaponeurotic spread limited to the area of insertion of the tendon. More frequent was the distal break of the longus division with extension along that tendon, deep to the lateral plantar space but separated from that space by its fascial floor. In a few cases, the extension continued across the gap between the malleolar and plantar sheaths of the longus tendon and passed into the foot external to the latter. In others the mass had continued from the malleolar into the plantar sheath through a normal communication.

An infection starting in the malleolar peroneal sheath will, therefore, probably spread, provided the sheath ruptures, proximally into the lateral leg space, and distally into the depths of the foot either by rupture of the sheath or through a normal communication between it and the plantar sheath. A less common spread would be subaponeurotically over the insertion of the peroneus brevis tendon.



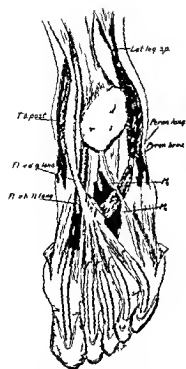


Fig 6

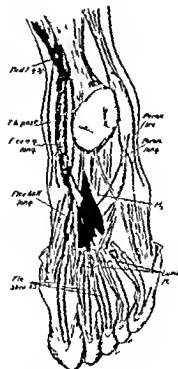


Fig 7

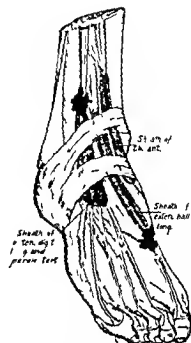


Fig 8

Fig 6 Plantar view showing spread of injection mass from ruptured serous sheaths of tibialis posterior, flexor hallucis longus and peroneal tendons

Fig 7 Plantar view showing spread of injection mass

**Extension from the plantar sheath of the peroneus longus tendon** In every case in which the plantar and malleolar sheaths communicated, the mass extended into the latter and spread from there in the usual manner (Fig 6). Aside from this, the commonest spread occurred by rupture through the distal end of the sheath into the plantar spaces M<sub>3</sub> and M<sub>4</sub>. Next in frequency were the ruptures proximally with subaponeurotic infiltration below the lateral malleolus. Breaks through the body of the sheath, which is well protected by the long plantar ligament, were very infrequent.

Infections starting in the plantar peroneal sheath (caused by deep nail wounds, etc.) will therefore probably remain localized at first in the depths of the foot, either confined within the tendon sheath or also in the deep median spaces, M<sub>3</sub> and M<sub>4</sub> from where further spread along the usual channels may occur secondarily. There may also be a subaponeurotic infiltration below the lateral malleolus and, in

from ruptured serous sheath of flexor digitorum longus tendon

Fig 8 Dorsolateral view showing spread of injection mass from ruptured serous sheaths of extensor tendons

those cases in which there is a normal communication, a spread into the malleolar sheath with secondary extensions from there.

**Extension from the sheaths of the extensor tendons** Since all three of these sheaths are confined to the region of the ankle and since the bodies of these sheaths are more or less protected by the annular ligament, we would expect them likewise to rupture at the proximal or distal extremities or both. The injection experiments confirm this (Fig 8). The most common ruptures were proximally leading to subaponeurotic infiltrations which spread a variable distance up the leg, deep to the fascial sheaths of the respective muscles, but with a definite tendency to remain localized in the region of the break. Almost as frequent were the ruptures at the distal or both ends. Distally, the infiltrations were also subaponeurotic along the tendons and with a definite tendency to remain localized. Less frequent sites of rupture were between the two portions of the annular ligament (liga-

mentum transversum cruris and ligamentum cruciatum cruris), where again the serous sheaths are unprotected

Infections starting in the extensor sheaths will therefore tend to be localized within these sheaths or in addition within subaponeurotic infiltrations at the proximal and distal ends

#### INCISIONS FOR DRAINING THE TENDON SHEATHS

It should be recalled that structurally the serous tendon sheaths are completely closed sacs with visceral and parietal layers which are in continuity on the deep side of the tendons much as the visceral and parietal layers of the peritoneum are in forming the mesenteries (Poirer and Rouviere, 1912) (Fig 9) Between these reflections the nutrient vessels enter the tendons. In the case of the digital sheaths, however, the mesotendons have been reduced in extent so as to be confined to the regions of the vincula which connect the superficial and deep tendons to bone and to each other (Treves, 1927, Piersol, 1923). Similarly in the case of the sheaths of the long flexor tendons behind the medial malleolus, the mesotendons are found only at the extremities, extending in a posteromedial direction. The mesotendon of the common peroneal sheath (malleolar) extends from the upper extremity of the sheath to the lower border of the malleolus, lying at the posterolateral side of the tendons. That of the plantar peroneal sheath is confined to the distal third of the sheath on the deep side and to the proximal third on the lateral side. On the other hand, the sheaths of the extensor tendons have mesotendons extending the entire length of the sheaths and lying at the posterolateral side of the tendons. In draining the serous sheaths, therefore, one should exercise the greatest care to open them from the side opposite the mesotendons (the superficial side in most cases) and furthermore, not to lift the tendons completely out of their sheaths and thus destroy their blood supply coming in from the depths. The visceral and parietal layers also become continuous at their proximal and distal extremities. As the tendon moves, the movement is between the serous surfaces of these layers and there is

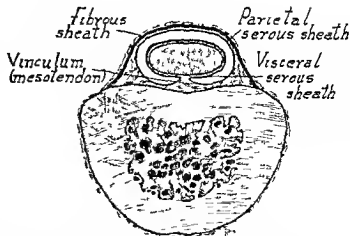


Fig 9 Cross section through distal end of first phalanx of great toe, showing relation of visceral and parietal layers of the serous sheath of its long flexor tendon

sufficient redundancy of the folds at the extremities to allow telescoping in at one end and out at the other, or vice versa

As previously described, the digital serous sheaths are protected externally by fibrous sheaths except at their proximal extremities, the plantar peroneal serous sheath is incompletely inclosed in a fibrous investment derived from the long plantar ligament and the tibialis posterior tendon, and the serous sheaths of the tendons in the ankle region are incompletely covered by the annular ligament. In addition, the tendon of the flexor hallucis longus muscle in its course under the annular ligament passes through a fibrous canal deep to the posterior tibial nerve and vessels. In draining the serous sheaths, these fibrous coverings must necessarily be incised first.

Two factors must be considered in the surgical treatment of infections of the tendon sheaths: first, drainage of the involved sheaths; second, drainage of any fascial spaces which may be secondarily affected. Incisions for draining the latter have been suggested on an anatomical basis in the earlier paper (Grodinsky, 1929). For the most part, as already suggested, the tendon sheaths are best approached by incisions directly over them. For the digital sheaths, the skin incision should begin just proximal to the distal interphalangeal joint and continue to or almost to the neck of the metatarsal bone. The outer fibrous sheath is exposed over the proximal or middle phalanx

and a small incision made through it. The serous sheath is then incised at that point and, if pus is obtained, opened its entire length by following a probe both ways. Instead of one continuous incision through the fibrous and serous sheaths, separate incisions may be made over the middle and proximal phalanges and the head of the metatarsal bone, skipping the interphalangeal and metatarsophalangeal joints and thus preventing prolapse (as suggested in the hand by Kanavel, 1921). There is so little of the tendon sheath on the distal phalanx that it is hardly necessary to extend the incision beyond the distal end of the middle phalanx. The lateral incisions recommended by Kanavel for similar conditions in the hand offer little advantage in the foot since the web extends to the proximal interphalangeal joint and the sheath over the second phalanx is the only part in the free portion of the toe. Furthermore since the second phalanx is lifted off the floor, the question of plantar scar on it is unimportant.

Infections of the long flexor tendon sheaths should be drained by incisions directly over them behind the medial malleolus. This is best accomplished by a small incision over the point of greatest localization in order to identify the sheath and then following down its whole length, a probe being used as a guide. It will be necessary to cut the annular ligament in this incision but anything short of this will give insufficient drainage and the cutting of this ligament, in my opinion, leads to no serious loss of function. The posterior tibial vessels and nerve must be carefully sought for and preserved in making these incisions because of their superficial position, particularly in opening the sheath of the flexor hallucis longus tendon which lies just deep to them within its fibrous canal, the roof of which must also be incised.

The common peroneal tendon sheath is opened by an incision parallel to it just behind the lateral malleolus. Here again the lateral annular ligament is cut and the sheath opened

its full length (both divisions inferiorly), using a probe as a guide. The peroneal artery lying just posterior to the sheath should be preserved. Where there has been a spread through a normal communication or break into the plantar sheath, the latter should be opened also. This is best accomplished by exposing and opening its proximal end, introducing a hemostat distally within the sheath and spreading the blades apart, thus eliminating the incision through the plantar surface and through all the layers of muscle with resulting poor drainage and plantar scar. If this sheath is being opened independently of the malleolar sheath, the proximal end may be found at the lateral border of the abductor digiti quinti muscle 2 to 3 centimeters posterior to the base of the fifth metatarsal bone. If it is necessary to drain the median plantar spaces (M<sub>2</sub>, M<sub>3</sub>, and M<sub>4</sub>), this is best accomplished by a medial incision along the anterior surface of the first metatarsal bone, lifting up the abductor hallucis and flexor hallucis longus and brevis muscles to reach the medial wall of these spaces, and then plunging a forceps at the proper level into the space involved (as described in my earlier paper, 1929). In the latter case, the distal extremity of the plantar peroneal sheath can be opened through M<sub>3</sub>.

The sheaths of the extensor tendons are drained by incisions directly over them and extending their entire length, cutting through the anterior portion of the annular ligament.

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## THE CALCIUM PARTITION IN PREGNANCY, PARTURITION, AND THE TOXÆMIAS

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THE subject matter of this paper covers first, a brief survey of the studies of calcium metabolism in pregnancy that are to be found in the literature to date, second, a consideration of the present day view of biologists as to the chemical nature and physiological importance of calcium in the human economy, and third, the presentation of findings in a group of pregnant and parturient women, based upon these more recent biological concepts.

There are two reasons for a complete reconsideration of this subject. First, calcium evidently plays an important rôle in the metabolism of pregnancy, and the understanding of this rôle is far from complete. Second, the conception of the physiology of calcium in the animal body has changed in recent years. This new concept of the chemical nature of this element in the body has not as yet been applied to the metabolic problem presented by obstetric phenomena.

An absorbing field for study and conjecture has long been presented to chemists and clinicians in such questions as the drain upon the maternal supply of calcium during pregnancy, the influence of toxæmia upon cell wall permeability to calcium and other important elements, or conversely the part played in the production of toxæmia by alterations of the permeability of body membranes due to fluctuations in calcium, the effect of lactation upon the calcium balance.

### PREVIOUS STUDIES

The studies that have been made in the field of pregnancy and parturition have been confined to determinations of the total calcium in the blood serum of mother and fetus. It will be well to mention several of these. In a study of the blood serum and ash of mother and fetus, K. v. Oettingen states that there is a preponderance of calcium and phosphorus in the ash of the human fetus, and that these

two substances are present in higher proportion in the fetal than in the maternal blood.

One would expect from this phenomenon a drain upon the calcium stores of the pregnant woman. While not all investigators are agreed, the majority report a definite decrease in the calcium content of the maternal blood serum. Deschamps, after studying a series of patients sums up the matter as follows: "We can conclude that during all the course of pregnancy, the calcium levels remain within the limits considered normal. However, in the last month of pregnancy, the levels are grouped near the inferior limits of the normal, some even are slightly below."

We have not found in the literature references to calcium determinations in the human being during parturition.

Turning to the puerperal period, we find that in a review of the literature of blood calcium determinations in the puerperium and in a summary of his own work, V. J. Harding states: "Figures on the level of blood calcium in the puerperium in women are scanty. DeWesselow shows a slightly lowered range of calcium values from the third to the eleventh day postpartum, while Handelman, Rose, and Sherwin give slightly higher figures, but still within normal variations. The average serum calcium value of 136 cases on the tenth day postpartum is 9.7 milligrams."

We could not possibly draw the conclusion that the production of a large amount of milk affected the level of the blood calcium. The figures of the five highest lactating women are within the usual normal range and are a little above the general average. The lowest calcium values are found in the women of the low lactating group. It appears difficult to raise the serum calcium by parathyroid extract during lactation."

In the toxæmias of pregnancy there has been little more than conjecture as to the rôle of calcium. Halverson, Mohler, and Bergeme

(7) found in the pernicious vomiting of pregnancy that the serum calcium was normal, while excretion of calcium, ammonia, and acid was very high. After alkali administration, there was an immediate drop in the calcium excretion. A similar rapid decrease in acidity and ammonia was noted. Apparently calcium excretion increased with an excessive acid production.

A theory as to the possible part played by calcium in the toxemia of late pregnancy is set forth by Wodon, who states: "Study of statistics published does not permit of the recognition of a hypoglycemic quality in eclampsia. But if the calcium total does not vary greatly, it is not the same with the ionic calcium. In fact, the mineral elements which enter into the composition of the body fluids do not exert their action unless they are in a state of ions."

Rona has proved that the quantity of calcium ions depends upon the intensity of the acid reaction of the medium, that is with the concentration of H ions in the medium. Most authors find in eclampsia a decompensated acidosis, that is to say, an abnormally increased concentration of hydrogen ions. There will be then also ionic hypercalcemia."

Such statements lead naturally to a brief discussion of the present day view of the physiology of calcium in the human economy.

#### PHYSIOLOGICAL CONSIDERATIONS

The importance of calcium in the maintenance of normal cellular activity is probably due to its regulatory influence upon the permeability of living membranes. Maintenance of the normal permeability of the surface membrane of the cell is essential to life and normal function, inasmuch as the permeability determines the exchange of materials between the interior and exterior.

Under ordinary resting conditions such membranes are impermeable to colloids and crystalloids, a state obviously incompatible with life, for it is essential that such substances as glucose and amino acids gain entrance to the cell and that waste products be excreted. It is clear that physiological variations in permeability must occur. McClendon has demonstrated that muscular contraction is

associated with an increased permeability to electrolytes, similar phenomena have been shown to occur during functional changes in other cells.

The influence of inorganic ions, particularly sodium, potassium, and calcium on the permeability of cell membranes is well known, normal permeability is dependent to a considerable degree on the presence of a normal balance between these elements in the fluid bathing the cell. Calcium definitely diminishes permeability, in fact, Loeb attributes the general inhibiting action of the calcium ion to this phenomenon. This important fact, long recognized by physiologists, has not received the consideration by clinicians which it deserves.

It is obvious that marked functional derangements may attend an alteration in the normal permeability of cell membranes which may in turn, be due to some disturbance of the inorganic ion balance. This problem has been studied by Kahn and Pick and by Andrews and Carter in relation to the cardiac mechanism and by Petersen in tuberculosis and other conditions.

An investigation of calcium metabolism must include more than the estimation of its intake, output, and concentration in the blood. Knowledge of the chemical state of the calcium in the blood and tissues is essential to the proper understanding of the manner in which the calcium balance is disturbed by disease. This subject is quite involved and there is still much to be learned concerning it. Certain facts, however, have been rather definitely established.

The normal serum calcium concentration is from 9 to 11 milligrams per 100 cubic centimeters. Physiologically this exists in two states, termed "diffusible" and "non diffusible." The diffusible fraction is that portion which is capable of passing through the capillary walls and cell membranes, the non diffusible normally can not, being bound in some way to the plasma proteins (the belief of most investigators). In a previous communication by one of us (A.C.) the normal figures for diffusible calcium were found to be 4.5 to 5.5 milligrams per 100 cubic centimeters, the non diffusible calcium being 4.7 to

575 milligrams per 100 cubic centimeters. These findings are in agreement with those of Halverson and Bergeim, Pincus and Kramer, Neuhauser and Pincus, and Updegraff, Greenberg and Clark, who found the diffusible calcium to be from 45 to 50 per cent of the blood serum calcium. In addition, a portion of the total calcium, estimated at about 20 per cent probably exists in ionized form, the remainder being un-ionized.

In view of these facts it is natural to expect that the pharmacological properties of the various calcium states (the diffusible, the non-diffusible, the ionized, and un-ionized) must be quite different. The production of a calcium effect is dependent not so much upon the level of calcium in the blood as upon its distribution in the blood and tissues. This may perhaps be best expressed by the ratio of the diffusible to the non-diffusible, and of the ionized to the un-ionized fractions. The ionized and un-ionized fractions cannot be satisfactorily determined by present methods.

The partition of calcium in the blood stream may be illustrated by the following equation

$$\left. \begin{array}{l} \text{Total serum} \\ \text{calcium} \\ 9 \text{ to } 11 \text{ milli} \\ \text{grams} \end{array} \right\} = \text{Diffusible calcium} + \left\{ \begin{array}{l} \text{Non diffusible} \\ \text{calcium} \\ 4 \text{ to } 5 \text{ milli} \\ \text{grams} \end{array} \right.$$

1 Ionized—2 milligrams?      2 Un ionized?

It can readily be seen that alterations in these ratios may occur without any change in the amount of serum calcium. That this actually is the case has been demonstrated in experimental anaphylaxis by Brown and Ramsdell and by one of us (A C 4), in atopic disorders and in some cases of pulmonary tuberculosis. Shelling and Maslow have demonstrated that, following the addition of citrate to serum *in vitro* and *in vivo*, practically all the calcium becomes diffusible, the total serum calcium level being unaltered.

There are two ways in which the diffusibility of calcium may be estimated: (1) by ultrafiltration or dialysis through an artificial membrane, (2) by the demonstration of the calcium content of cerebrospinal fluid. The latter method has been attacked by some investigators on the ground that the cerebro-

spinal fluid has not been definitely proved to be a protein-free filtrate of blood plasma. This question is beyond the scope of the present discussion and has been gone into more fully in a previous communication (3). There appears, however, to be justification for considering the spinal fluid calcium to be the diffusible fraction of the blood serum calcium. On the other hand, it must be realized that the diffusibility of calcium in the body, like that of any constituent of the blood, depends upon two variable factors, first, the chemical state of the element in the blood stream, and second, the permeability of the capillary walls and cell membranes.

When ultrafiltration or dialysis is employed to determine the diffusibility of calcium the influence of the state of permeability of the living membranes is disregarded. Until more is known concerning the exact nature of the non-diffusible fraction of the blood calcium the ultrafiltration method cannot be accepted as furnishing correct information regarding the distribution of calcium in the tissues, particularly in conditions which are apparently associated with alterations in cell permeability. Under normal conditions, however, the figures obtained by the two methods are practically the same.

#### METHOD OF STUDY

This study consists in the determination of the calcium content of blood serum and of spinal fluid in a number of obstetric patients. The specimens were collected simultaneously at varying periods of pregnancy and parturition. While the cases reported present quite a diversity of conditions, they may be placed in five groups: early pregnancy, late pregnancy, toxemias of pregnancy, first stage of labor, and second stage of labor.

The calcium content of the blood serum is represented by the "total" (T) calcium, the calcium content of the cerebrospinal fluid is termed "diffusible" (D) calcium, the difference between the total and diffusible is termed non-diffusible (ND) calcium. The values are all expressed in milligrams per 100 cubic centimeters.

The calcium determinations were made by the Clark-Collip modification of the Kramer-Tisdall method (5).

TABLE I—THE TOTAL SERUM CALCIUM, THE DIFFUSIBLE AND NON DIFFUSIBLE CALCIUM AND THE RATIOS OF DIFFUSIBLE TO NON DIFFUSIBLE AND TO TOTAL CALCIUM IN PATIENTS DURING PREGNANCY, LABOR, AND IN THE LATE TOXÆMIAS

Condition	Cases	Serum calcium	Diffusible calcium	Non-diff calcium	D/N/D	D/T
Early pregnancy	5	9.52-11.59	4.83-5.71	5.81-6.76	74.4-150	41.6-60.0
Late pregnancy	10	8.02-11.00	4.45-6.82	5.71-6.50	69.2-232	40.9-69.6
Labor 1st stage	21	8.02-11.16	4.57-6.82	5.40-5.91	76.0-414	41.4-50.5
Labor 2nd stage	3	9.60-11.00	5.20-6.00	4.24-5.40	103-141	50.9-53.6
Toxæmias (late)	7	10.5-13.5	4.45-5.5	6.05-10	53.4-73.5	31.8-42.5
Normal		9.00-11.00	4.50-5.50	4.50-5.50	50-115	45-55

Calcium values expressed in milligrams per 100 cubic centimeters  
 D/N/D—ratio of diffusible to non-diffusible calcium  
 D/T—ratio of diffusible to total serum calcium

#### EXPERIMENTAL DATA

The pertinent data are presented in Tables I and II. The patients have been grouped under five headings: (1) normal early pregnancy—before 4 months, (2) normal late pregnancy—after 4 months, (3) normal labor, first stage, (4) normal labor second stage, (5) complications of pregnancy including nephritis, pre eclamptic and eclamptic toxæmias, hyperthyroidism, abortion, miscarriage, and polyhydramnios.

For purposes of emphasis, in the following presentation of data, the findings are also considered under the headings of (1) serum calcium, (2) diffusible calcium, (3) non diffusible calcium, and (4) ratio of diffusible to non diffusible calcium.

**Serum calcium.** Of 5 patients in early pregnancy the serum calcium was within the normal limits of 9 to 11 milligrams per 100 cubic centimeters in 3. In 2 patients the figures were above normal (11.2, 11.59).

Of 10 patients in late pregnancy the serum calcium was within normal limits in 7. In 3 it was below normal (8.02, 8.29, 8.79).

In 12 of 21 patients in the first stages of labor the serum calcium was within normal limits. It was below normal in 7 cases (7.2—8.97) only one being below 8 milligrams per 100 cubic centimeters. Figures above normal were found in two cases (11.10, 11.16).

TABLE II—THE TOTAL SERUM CALCIUM, THE DIFFUSIBLE AND NON DIFFUSIBLE CALCIUM, AND THE RATIOS OF DIFFUSIBLE TO NON DIFFUSIBLE AND TO TOTAL CALCIUM IN COMPLICATIONS OF PREGNANCY

Condition	Serum calcium*	Diffusible calcium	Non-diff calcium	D/N/D	D/T
Eclampsia	12.8	4.46	8.34	53.4	31.8
Eclampsia 4 days postpartum	8.45	4.75	3.70	128	56.2
Pre-eclampsia	12.4	4.02	7.48	65.7	30.6
Pre-eclampsia 4 days postpartum	10.45	5.22	5.23	100	50.0
Pre-eclampsia	15.5	5.50	10.00	55	35.4
Hyperthyroid 1.8 mo	11.0	4.5	7.5	60.0	37.5
Pre-eclampsia 7.5 mo	10.5	4.45	6.05	73.5	47.5
Pre-eclampsia 20 mo	11.35	4.55	6.8	65.0	40.0
Nephritis toxæmia	12.03	4.83	7.18	67.5	47.5
Pre-eclampsia 7 mo	9.45	4.57	4.01	92.0	47.9
Pre-eclampsia 9 mo	9.75	6.82	2.93	131	69.9
Acute polyhydramnios	9.0	5.74	4.66	117	53
8 mo moderate edema	9.51	4.76	4.76	100	50
7 mo lues—dead fetus	7.8	4.7	3.1	151	60.2
6 mo miscarriage	11.6	6.6	5.0	132	56.8
7 mo miscarriage	10.6	6.30	4.40	140	58.4
Threatened abortion	10.47	6.25	4.19	149	59.9
8 mo encephalitis	9.75	6.82	4.91	132	69.0
Pre-eclampsia 7 days postpartum	11.00	5.55	5.55	101.3	47.7

Calcium values expressed in milligrams per 100 cubic centimeters  
 D/N/D—ratio of diffusible to non-diffusible calcium  
 D/T—ratio of diffusible to total serum calcium

In 3 patients in the second stage of labor the serum calcium values were within normal limits.

The individual figures in the complications of pregnancy are shown in Table II. It is interesting to note that in the 7 patients with eclamptic, pre eclamptic, nephritic and thyroid toxæmia, the serum calcium values were above normal (11.35—15.5) in all but one (10.5).

**Diffusible calcium.** Considering the normal figures for spinal fluid calcium to be 4.5 to 5.5 milligrams per 100 cubic centimeters, normal values were found in 4 of 5 patients in early pregnancy. A figure above normal was found in one patient (5.71).

Of 10 patients in late pregnancy the diffusible calcium was within normal limits in

TABLE III—AVERAGES OF CALCIUM VALUES OBTAINED IN EACH GROUP

Condition	Serum calcium	Diffusible calcium	Non-diff calcium	Ratio D/ND†
Early pregnancy	10.61	5.08	5.53	96.6
Late pregnancy	9.45	5.34	4.20	139.58
Labor—1st stage	9.62	5.66	3.94	162.8
Labor—2nd stage	10.38	5.60	4.83	120.7
Toxæmias	12.36	4.74	7.62	63.14

Calcium values expressed in milligrams per 100 cubic centimeters  
†Ratio of diffusible to non diffusible calcium expressed as percentage

6 It was above normal in 2 (5.85, 6.82), and below normal in 2 patients (4.45, 4.45)

In 9 of 21 patients in the first stage of labor, the figures were within normal limits. They were above normal in 12 cases (5.65—6.82)

In one patient in the second stage of labor the diffusible calcium was normal. In 2 it was above normal (5.6, 6.0)

Of the 7 patients with toxæmia as shown in Table II, the diffusible calcium was within normal limits in 5. In 2 the figure was very slightly subnormal (4.46, 4.45)

**Non-diffusible calcium:** In 2 of the 5 patients in early pregnancy, the non-diffusible calcium was within normal limits of 4.7 to 5.75 milligrams per 100 cubic centimeters. It was above normal in 2 (6.15, 6.76) and below normal in 1 (3.81)

Of 10 patients in late pregnancy 3 were within normal limits. Values above normal were found in 1 (6.5) and below normal in 6 (2.71—4.49)

Of 22 patients in the first stage of labor the non-diffusible calcium was within normal limits in only 3. It was above normal in 2 (5.81, 5.94), and subnormal in 16 (1.4—4.68). Twelve of the subnormal figures were below 4 milligrams per 100 cubic centimeters

In one patient in the second stage of labor the non-diffusible calcium was normal, in 2 it was subnormal (4.24, 4.4)

In the 7 toxic patients the non-diffusible calcium values were above normal (6.05 to 10)

**Ratio of diffusible to non-diffusible calcium:** Of the 5 patients in early pregnancy, this ratio was within the normal limits of 82 to 115 per cent in 2. It was above normal in 1 (150) and below in 2 instances (71.4, 81.2)

TABLE IV—THE NUMBER OF CASES IN EACH GROUP WITH NORMAL, INCREASED AND DECREASED VALUES FOR SERUM CALCIUM, DIFFUSIBLE AND NON-DIFFUSIBLE CALCIUM AND RATIO OF DIFFUSIBLE TO NON-DIFFUSIBLE CALCIUM

Condition	Serum calcium			Diffusible calcium			Non-diff calcium			Ratio D/ND		
	Normal	+	-	Normal	+	-	Normal	+	-	Normal	+	-
Early pregnancy	5	2	0	4	1	0	2	3	1	2	1	2
Late pregnancy	7	0	3	6	2	2	3	1	6	3	6	1
Labor—1st stage	12	3	7	9	12	0	3	2	16	4	16	1
Labor—2nd stage	3	0	0	1	2	0	1	0	2	1	2	0
Toxæmias	1	6	0	5	0	2	0	7	0	0	0	7

Of the 10 patients in late pregnancy the ratio was normal in 3. It was elevated in 6 (130—232) and diminished in 1 (69.2)

Of the 21 patients in the first stage of labor, this ratio was normal in 4 only. It was above normal in 16 cases (123—414) and below normal in 1 (76.9)

Of the 3 patients in the second stage of labor, the ratio was normal in 1. It was above normal in 2 cases (118, 141)

In all 7 toxic patients, the ratio was subnormal (53.4—73.5)

#### SUMMARY

As stated earlier in this paper, it has been rather generally observed that the calcium content of the blood diminishes in the latter months of pregnancy. Our determinations of the total serum calcium are in agreement with these findings. We have found, however, that in addition to this decrease in total serum calcium there is a quite noticeable deviation from the normal distribution of the various forms of calcium, and that this deviation extends not only into late pregnancy but becomes more marked in the early stage of labor.

The majority of the determinations of total serum calcium made during pregnancy and the first stage of labor lie within the lower limits of normal. In only one patient was the serum calcium below 8 milligrams per 100



cubic centimeters (7.2 milligrams—labor first stage) In the few cases in which specimens were collected in the second stage of labor the trend was toward a higher value for serum calcium

The diffusible calcium appears to increase slightly as pregnancy progresses, reaching a maximum during the first stage of labor This increase is shown better by a consideration of the number of individual cases with figures above the upper limit of normal variation (Table IV) than by the average values (Table III)

The non diffusible calcium decreases rather strikingly, reaching a minimum in the first stage of labor This diminution is demonstrated both by the average figure for each group and by the relative number of determinations above, below and within the normal limits of variation (Tables III and IV)

The alteration in the partition of calcium which occurs during pregnancy and labor may be more clearly shown by considering the ratio of the diffusible to the non diffusible fraction The average results, which are of little significance in a small group of cases, are shown in Table III The analysis of the individual cases shown in Table IV, bears out, however, the striking alterations in the ratio of diffusible to non diffusible calcium shown in Table III

During the course of pregnancy and during the first stage of labor there occurs a gradual and definite increase in this ratio, which reaches a maximum during labor The decrease in the ratio which apparently occurs in the second stage of labor is of questionable import in view of the fact that there were only 3 patients who were studied in this latter group of cases

The significance of this disturbance of calcium balance cannot be stated It is interesting to note that in a previous study (4) a constant definite increase in the ratio of diffusible to non-diffusible calcium was found in bronchial asthma and allied disorders and in some patients with pulmonary tuberculosis The partition of calcium observed in these disorders of an atopic nature is identical with that found in the present study of patients in the first stage of labor

The observations in the toxæmic complications of pregnancy are of particular interest There were 7 patients in this group, 1 with eclampsia, 5 with pre eclamptic toxæmia, and 1 with moderate hyperthyroidism With one exception all were in the late months of pregnancy All presented practically identical findings The serum calcium in 6 of the 7 cases was above normal, exceeding 12 milligrams per 100 cubic centimeters in 5 instances This is in rather marked contradistinction to the calcium level in the later months of normal pregnancy The diffusible calcium was within normal limits in 5 of the patients In the 2 others it was just below normal limits (4.45, 4.46) The non diffusible calcium was increased in all cases and as a result, the ratio of diffusible to non diffusible calcium was sharply diminished in each instance This diminution is quite in contrast to the increase in this ratio which appears characteristic of the same period (the latter months) of normal pregnancy

The constancy of this finding may be of fundamental importance Its significance can only be conjectured The observations in these toxic patients would suggest the presence of a state of diminished cell permeability, a condition which might well be associated with the marked disturbance of function which occurs in various organs in the toxemias of pregnancy

#### CONCLUSIONS

1 During the course of normal pregnancy and early labor there is a gradual diminution of total serum calcium, a slight increase in diffusible calcium, and a marked decrease in non diffusible calcium

2 The ratio of diffusible to non diffusible calcium increases steadily, reaching a maximum in the first stage of labor This disturbance is identical with that present in bronchial asthma and allied disorders

3 The toxemias of pregnancy are characterized by a marked decrease in the ratio of diffusible to non diffusible calcium, due in most instances to an increase in the non diffusible fraction This finding suggests a condition of diminished cell permeability with associated disturbance of tissue functions in these disorders

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## THE ASCHHEIM-ZONDEK REACTION FOR PREGNANCY

## RESULTS IN 100 CASES

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**A** RELIABLE laboratory test for the early diagnosis of pregnancy has been a long felt want. The most recent and seemingly the most promising of the many attempts made to satisfy this desire is the Aschheim Zondek reaction which has for its basis the presence in the urine during pregnancy of large amounts of anterior pituitary hormone. Hypertrophy of the anterior lobe of the hypophysis during pregnancy was recognized by Erdheim and Stumme. Further, Aschheim and Zondek showed that the anterior lobe (aside from its effect upon body growth) produced a substance capable of initiating the development of immature ovaries. They called this hormone the "motor" of the sex glands and found it to be excreted in the urine in active amounts during pregnancy. Since they were unable to demonstrate the presence of this hormone in the urine in conditions other than the gravid state, their reaction is superior to tests which depend upon metabolic and serological changes not specific for pregnancy (Abderhalden reaction, maturin test, antithrombin test, epinephrin test, etc.).

The changes produced in the ovaries of immature mice after the injection of urine obtained from cases of pregnancy are identical with those seen after the implantation of anterior lobe tissue and are recognizable at the end of 100 hours. The authors distinguish three characteristic reactions:

**Reaction 1** Ripening of follicles, ovulation, œstrus. The primordial follicle increases in size and develops a cumulus oophorus. Following maturation the follicle ruptures and the ovum enters the fallopian tube, corpus luteum formation follows. Under this influence of the anterior pituitary hormone the ripening follicle secretes the ovarian hormone which in turn produces œstrus, recognized through enlargement and congestion of the uterus, accompanied by hypertrophy

of the vaginal membrane and cornification of the upper cell layer (Allen test).

**Reaction 2** "Blood spots" (hemorrhagic follicles). The hyperemic ovary with greatly dilated blood vessels shows massive hemorrhages within the cavity of mature, partially luteinized follicles. This characteristic reaction is recognizable macroscopically by brown elevations the size of a pin head which give the ovary a mulberry appearance.

**Reaction 3** Luteinization of follicles. For maturation of corpora lutea atretica. The luteinization of the theca and granulosa cells takes place so rapidly as to imprison the ovum (corpus luteum atreticum).

The changes described above are so striking that they may be recognized macroscopically in the majority of instances. For the diagnosis of pregnancy the presence of reaction 1 alone must be considered negative or, at the most, suggestive, whereas reaction 2 or 3 is diagnostic. A microscopic tissue examination is advisable in all doubtful or apparently negative cases.

A positive Aschheim Zondek reaction when obtained by the injection of urine into immature mice indicates the presence of living tissue derived from a fertilized ovum. The test is therefore positive in all cases of uninterrupted intra uterine and extra uterine pregnancy, as well as in cases of hydatidiform mole and malignant chorio epithelioma. The reaction is strongest during the earliest months of gestation, becomes weaker as pregnancy approaches term, and disappears about one week postpartum. Urines obtained some time after intra uterine fetal death, missed abortion, tubal rupture or tubal abortion may no longer give a positive reaction. As long, however, as the ovum or any of its elements are alive and proliferating the test will remain positive.

For the past 5 months we have been using the Aschheim Zondek reaction to determine

its dependability as an aid to clinical practice. The results obtained thus far have been most satisfactory, and we are able to confirm in every respect the claims made by its originators. We are now able to report a total of 100 cases in which our reports have been checked clinically.

The details of our technique are practically identical with those recommended by Aschheim and Zondek in their original report. The urines submitted to us have come almost entirely as unknowns—cases seen either in the Out Patient Department of Harper Hospital or cases from private practice in which the diagnosis could not be made by clinical methods. Our series, therefore, does not contain a large number of controls made upon normal individuals but rather represents a trial of the reaction as a diagnostic procedure.

#### TECHNIQUE

To carry out the test we have used, whenever possible, the first morning specimen of urine, since it is more concentrated and contains the hormones in greatest quantities. One ounce of urine is sufficient for the test and is kept refrigerated in a clean, not necessarily sterile container. A few drops of acetic acid are added if the urine is alkaline or neutral, one drop of lysol or tricresol serves as a preservative. Medication of the patient or the addition of more than minimal amounts of preservative occasionally results in death of the animals.

The mice used are immature females, 3 to 5 weeks of age and weighing 6 to 8 grams. It is very important that these limits be strictly adhered to. Older mice may no longer be immature and will give false reactions, and younger mice do not tolerate injections well.

Five mice are used for each test since all mice do not react equally, and some may die from other causes during the course of the injections. Each mouse receives an injection of 0.3 cubic centimeters of urine subcutaneously twice a day for 3 days, six injections in all. At the end of 100 hours, 1 e at the beginning of the fifth day, the mice are autopsied and the reaction determined by the appearance of the ovaries. Microscopic sections were made in all cases in our series.

The following tables summarize our results.

TABLE I —NORMAL INTRA-UTERINE PREGNANCY

Gestation	No Cases	Positive	Negative	Error
5 to 6 weeks	13	13	0	0
7 to 8 weeks	8	8	0	0
3 to 10 months	28	28	0	0
Postpartum 2 to 7 days	4	4	0	0
Total	53	53	0	0

The earliest diagnosis was made from a specimen of urine obtained 3 days after the expected date of menstruation, four specimens were positive on the seventh day.

TABLE II —NON-PREGNANT SUBJECTS

Condition	No Cases	Positive	Negative	Error
Amenorrhoea	18	1	17	1
Menopause	4	0	4	0
Uterine fibroid	3	0	3	0
Ovarian cyst	2	0	2	0
Uterine carcinoma	2	0	2	0
Normal male	3	0	3	0
Normal female	3	0	3	0
Total	35	1	34	1

The false positive reaction obtained in this group might be explained as a technical error inasmuch as only 1 of the 5 mice showed a positive reaction, the others being definitely negative. The case was one of a functional amenorrhoea. Another specimen of urine was not obtained for re-examination, but it is definitely known that the patient has since menstruated normally and was not pregnant.

TABLE III —ABNORMAL PREGNANCY

Condition	No Cases	Positive	Negative	Error
Threatened abortion	1	1	0	0
Incomplete abortion	2	1	1	0
Tubal pregnancy	2	2	0	0
Hydatidiform mole	2	2	0	0
Chorio epithelioma malignum	5	5	0	0
Total	12	11	1	0

The negative reaction obtained in one case of incomplete abortion cannot be considered a false reaction since at the time the urine was obtained nothing remained *in utero* save a few fragments of necrotic placental tissue. The positive reactions in cases of malignant chorio-epithelioma represent specimens obtained at different times from 2 cases following

hydatidiform mole These cases are now being studied carefully, and we hope in the near future to report some interesting and important findings

TABLE IV — SUMMARY

	No. Cases	Positive	Negative	Error
Normal pregnancy	53	53	0	0
Non pregnant	35	1	34	1
Abnormal pregnancy	12	11	1	0
Total	100	65	35	1

The results obtained are approximately the same as those originally published by Aschheim and Zondek. In their series of 197 cases of normal pregnancy, the reaction showed an error of 2 per cent, controls (non pregnant subjects) an error of 1.6 per cent. Ehrhardt's series of 197 cases showed correct diagnoses in 98.5 per cent. Other authors have reported smaller series with an accuracy of 100 per cent. We do not believe that such small numbers permit drawing any definite conclusions.

Louria and Rosenzweig have published a series of 132 cases with an accuracy of 98 per cent in cases of pregnancy, and an accuracy of only 91 per cent in their controls. An undoubted source of error in their method was their use of mice weighing 12 to 15 grams. According to Aschheim and Zondek, a mouse weighing 12 grams can no longer be considered definitely immature. This no doubt explains the large numbers of false reactions obtained by them.

It appears evident on the basis of the results thus far obtained that the Aschheim Zondek reaction offers a very reliable and practicable means for the early diagnosis of pregnancy, particularly in those cases in which associated pelvic tumors, etc., require an accurate dif-

ferential diagnosis. The results show an accuracy equal to, if not exceeding, those of other recognized biological tests, and its simplicity allows it to be carried out without elaborate apparatus or specially trained technicians. The urine when treated with a small amount of preservative remains potent for a long time under ordinary conditions. It would be entirely feasible for a biological laboratory to carry out this reaction very much in the same way as our state laboratories carry out the Wassermann reaction on a large scale.

#### CONCLUSIONS

1. The Aschheim Zondek reaction offers a very reliable laboratory method for the early diagnosis of uninterrupted intra uterine and extra uterine pregnancy, hydatidiform mole, and malignant chorio epithelioma.

2. Its simplicity permits it to be carried out without elaborate equipment.

3. It has been proved a valuable adjunct to ordinary clinical methods in difficult problems involving the diagnosis of pregnancy.

NOTE.—Since this article was accepted for publication, reactions have been done in 259 additional cases making a total of 259. The accuracy in the entire series was 98.8 per cent.

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ART OF SURGERY<sup>1</sup>

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**S**URGERY is essentially an art, although in present day surgery it is so closely blended with science that the dividing line between them is indistinguishable. In the early days surgery was an art and nothing more, due to the fact that all knowledge was acquired by the repeated application of elementary knowledge. Nothing was known, then, of the fundamental principles on which the science of medicine and surgery was established. Little was known about anatomy and less about pathology.

From the earliest time, wounds in the different tissues have occurred as the result of trauma. Caring for laceration and inflammation naturally resulted in the gradual accumulation of knowledge concerning these conditions, and it was the application of this knowledge which developed into the art of surgery. All surgeons are, in a sense, artists, and some teachers of surgery still think that craftsmanship, or the artistic use of the hands in performing surgical operations, is a major element in progress in this work. (Cutler) Unfortunately, others feel differently, and prefer to classify some as operators and others as surgeons, the distinction presumably being that the surgeon is a scientist as well as an operator. It seems to me that as a result of the training now required in medical schools, it is not possible for anyone to obtain a degree without thorough scientific training, so that all surgeons are scientists before they have obtained any knowledge which may be applied to practical purposes.

Certain surgeons are more interested in the development of craftsmanship than are others. Usually they have a natural liking for the artistic and enjoy seeing an operation well performed, without trauma to tissue, loss of blood, or loss of time, and with a certain scientific knowledge employed throughout the operation which enables them to recognize tissues and to avoid unnecessary handling of them. Others devote all their interest to the scientific side of surgery, and to them each

case is just a scientific problem. Most of these do not operate frequently enough, or with enough interest, to become familiar with the operative field. Others have no liking for or ability to learn the craftsmanship which makes skillful surgery.

It is not as though each operation for a certain condition involved the performance of just the same technical steps. No two cases are exactly alike in every respect, so it is necessary for anyone who wishes to become a good operating surgeon to perform many operations for each condition in order that he may become familiar with the normal conditions as well as with the anomalies and the different pathological processes that may be encountered.

To believe that one who is proficient in the fundamental sciences and who has carried out some intricate and valuable researches is qualified to perform any operation is not fair to him or to his patient. The art of surgery and the development of craftsmanship must be learned slowly, step by step, and so must be learned just as the science of surgery is mastered.

## EXPOSURE OF FIELD OF OPERATION

Proper exposure of the tissues to be operated on is the most important technical step in an operation. If the field can be brought into view, the operation can be carried out accurately and without trauma to neighboring tissue. Working with insufficient exposure may result in serious hemorrhage or in such trauma as the severance of the common bile duct. If the proper exposure is obtained, this accident need never occur. Holding the tissues away and retracting is largely the assistant's duty, under the supervision of the surgeon. In my experience one of the most difficult tasks a surgeon has to perform is to teach his assistants this part of the operation. Some students will grasp the idea of exposure readily but it has been my experience that it takes the average student about a year of

<sup>1</sup>Presidential address before the Western Surgical Association, Del Monte, California, December 12, 1919.

work as a first assistant before he realizes the importance of this part of the art of surgery. When he has grasped this idea then he really is a surgeon and capable of operating. Without this training no one can learn the art of surgery except by blundering through operations until he works these steps out for himself, and leaves behind a trail of unsatisfactory results which are a discredit to surgery.

There are many factors which aid in bringing the field into view. It is essential to have the patient in the proper position on the operating table. This is especially important in brain surgery, orthopedic surgery, and in certain operations on the kidney. A simple operation on the kidney may be made very difficult by the improper position of the patient. Properly placed incisions of sufficient length to allow operating freedom may mean the difference between a very satisfactory or a most unsatisfactory operation.

Some persons naturally have an artistic sense while others must strive hard to do anything in an artistic manner; therefore some use their hands very well in performing an operation while others do not. To watch Moynihan, Crile or Cushing at work in their operating rooms makes surgery look very easy; this is largely because they are artists in their work. There can be nothing more satisfying than to watch Moynihan perform an operation on the stomach or biliary tract or to see Crile carry out in a most delicate manner a block dissection of the glands of the neck, or to observe Cushing during a long tedious difficult operation for removal of a tumor of the brain. We cannot all hope to attain anything like the accuracy and artistic ability that these men have achieved, but I would like to suggest that in watching these artists of surgery that you observe how much they employ their hands in the handling of tissues and in retracting, for exposure of the field of operation.

Retractors are necessary, but they should be employed with as little force and trauma to the tissues as possible. Clamping blood vessels with hemostats can be done in an artistic manner or it can be done clumsily, with injury to tissues around the vessel. It is not necessary to search out each small vessel

and divide it between clamps, as often this results in a time consuming puttering type of operation which is anything but artistic. If large clamps are used, greater care in avoiding injury to tissues is necessary. The object of the clamping of vessels is to keep the operative field dry and free from blood during the performance of the major part of the operation. Operating in a bloody field is not as annoying to some surgeons as to others, nevertheless, the drier the field the more accurate the technical steps will be, and accuracy means avoidance of anatomic structures, better wound healing and better results, and that is what constant attention to the art will accomplish. Tissue crushed by clamps or traumatized by rough retracting may be the cause of a result that is discreditable.

Many operations are time consuming because just so much operating must be done and any attempt to hurry through them is certain to result badly. Most operations have a certain routine for at least a part of the procedure and one who has had experience becomes familiar with the routine of the operation, as a result, he can save much time. Time is important, but it is always secondary to technique and art. Handling tissues repeatedly after they have been definitely identified and speculating on all sorts of possibilities during the time the patient is anesthetized and the wound is open, does not constitute artistic surgery and can do as much harm as speeding through the steps of the operation.

Souttar stated "Surgery is essentially an art for it demands of those who would pursue it a combined dexterity of hand and eye, and an instinctive perception of values which are the characteristics of the true artist." To show that he feels that the art and science of surgery are inseparable, he goes on to say that its practice rests on a mass of knowledge, the accumulated experience of generations, which is likely to overwhelm the student by its mere bulk and to obscure his vision of the whole in a mass of detail.

#### LIGATURES AND SUTURES

Tying divided blood vessels was introduced by Pare in the sixteenth century. Before this

time, and even to a considerable extent afterward, hæmostasis was accomplished by searing the bleeding vessel with a hot iron or by pouring some hot material over the bleeding surface. When ligatures were first introduced they were not altogether satisfactory, for nothing was known of asepsis or antiseptis, so that all wounds were infected and doubtless many of the ligatures sloughed off and secondary hæmorrhage ensued. The control of hæmorrhage was the greatest problem in the early days of surgery. It is still a great problem, but under most conditions bleeding from any source is controlled without too great difficulty. The progress in surgery is demonstrated by the improvements in the methods and ability permanently to control bleeding vessels. This of course is secondary to, and dependent on the principle of asepsis. Not so long ago, it was not uncommon to have a patient succumb during the performance of an operation because of uncontrollable bleeding. This unfortunate experience rarely occurs at the present time. Manual dexterity can be acquired only by much practice and skill is necessary even in the application of a ligature. Bland-Sutton speaking of the value of asepsis in a lecture on 'Faith in Ligatures' said that clumsiness associated with aseptic precautions often ends in success but that dexterity associated with asepsis invariably wins. In the institution in which I operated more than 25 years ago secondary hæmorrhage after extensive operative procedures occasionally was encountered. The cause of the hæmorrhage in most of these cases was not that the ligature gave way or slipped off the vessel but rather, I believe, to the fact that the vessel really never had been tied. It had been grasped in the forceps and divided but in the tying of the ligature removal of the clamp had allowed the end of the vessel to drop back. The result was that the tissue over it had been tied, and as soon as the crushed end of the vessel opened, bleeding into the tissues occurred. In reoperating in these cases and searching for the source of the bleeding the end of the vessel would be found entirely free, but retracted into the surrounding tissue. This was evidence of failure in the artistic performance of the operative pro-

cedure. As soon as the cause of these failures was realized it was corrected by proper isolation of the end of the vessel from its bed in the surrounding tissue before the ligature was applied. Jumping of the hæmostat just at the time the knot is tied may result in retraction of the end of a vessel and should be cautiously avoided. Secondary hæmorrhage is almost never seen in this age because of the fact that the art of surgery has developed to the point at which all vessels are securely ligated at the completion of the operation. Contrary to the ideas of some surgeons, it is not necessary to tie a vessel with a ligature of great size or durability. The point is that the vessel itself must be properly ligated without other tissue being included.

Skill is necessary in the placing of sutures in order properly to approximate the tissues and yet not to strangle them which results in necrosis and giving way of the suture line. In the earlier textbooks of surgery many intricate and puzzling methods of suturing are described, these have served the purpose of impressing on us the importance of accurate suturing and also have served as a step in the development of the art. We have gradually learned that these complicated technical methods are unnecessary and that the simpler methods are not only easier and quicker but also that they approximate the tissues more accurately with better prospects of proper healing, and are less likely to result in bleeding and necrosis.

The artistic surgeon uses smaller needles and strands for suturing. Absorbable materials are rather generally employed, but the large rough materials cause much more trauma to the tissues and do not bring about as good healing or result in the fine scar that follows the use of fine sutures. Absorbable suture, to my mind is used many times when a fine, non-absorbable material would be a better suture.

It seems to me that the workman who does his work in as simple a way as possible usually does the best job. Simplicity means the following: the easiest and surest way of preparing the patient for his operation, the smallest number of assistants that it is possible to have, the simplest instruments and other



materials to come in contact with the operative field, the simplest way of cleansing the skin before making the incision, and the simplest method in preparing the hands of the operators and assistants. Cumbersome, complicated ways of doing things are not allowable in the development of the art of performing surgical operations.

#### ANÆSTHESIA

Few of us can realize what the discovery of anæsthesia has meant. One has only to read Halsted's monograph on the thyroid gland, in which he describes the operations for goiter performed in Germany before any anæsthetic was known, to get some idea of the horrors of surgery in that day. Certainly surgery could not have existed long under those circumstances. Anæsthesia by ether was discovered in 1846, and by chloroform about a year later. These discoveries opened up an entirely new era for the art of surgery and was one of the openings for the science of medicine. Ether and chloroform by inhalation were the only anæsthetics used for several years; then other drugs were introduced which were to be injected locally to produce local anæsthesia or into the nerves themselves to produce anæsthesia in the region supplied by these nerves.

Proper administration of the anæsthetic is an art in itself. No part of the art of surgery requires more painstaking care, judgment and craftsmanship than does the art of selecting and properly administering an anæsthetic. From experience, the surgeon learns what type of anæsthetic will best suit the needs in certain cases. If he is always observing during the operation he learns to estimate the patient's condition without asking the one who is actually administering the anæsthetic. The anæsthetic is the surgeon's responsibility and I think should be administered to the patient in the surgeon's presence. It is not a good plan to divide responsibility in a surgical operation. When local and spinal anæsthesia are used, the result, in anæsthesia, will be obtained according to the skill of the one who made the injection. To do this work well requires a great deal of skill and this can be obtained only by long experience and intense

interest by one who is anxious to become proficient in the administration of anæsthesia and not by one who is using this part of the art of surgery to advance to some other position.

The same thing may be said about the use of drugs intravenously as a means of inducing general anæsthesia. This is a comparatively new development, but from the reports and experiences to date, it offers a possibility that may work out to great advantage. After the pharmacology involved has been determined, intravenous administration is purely a matter of craftsmanship and usually can be much more skillfully carried out by a trained technician who has learned the craft by long experience than by one with much more knowledge but with less skill. The drug that is to be used, and the amount that is to be given, are matters for the surgeon to decide.

Our knowledge of anæsthetics has progressed tremendously in the last few years. The anæsthesia is more complete now than formerly, better relaxation is obtained, there is less risk, fewer catastrophes occur, and inconvenience to the patient is much less. Operating on a patient who is completely relaxed is quite different from operating on one who is straining, is cyanosed, or is not breathing properly. Complete relaxation of all muscles means so much in every part of the operation that it has resulted in a great wave of enthusiasm for spinal anæsthesia in recent years. The most complete relaxation is obtained by this method. Heretofore it has been considered too dangerous to employ generally, but apparently some of the dangers have been eliminated, and if the results continue to be as satisfactory as they have been recently, it is sure to come into wide use. It allows artistic performance of the operation, in which every structure is recognized through easy exposure and all vessels either are avoided or accurately ligated. All nerves are avoided and after the operation is completed all structures are returned to their proper relations and the layers of the wound are easily closed without tension.

The first requirement of an anæsthetic is that it will produce anæsthesia without endangering the life of the patient. The second requirement is that it will accomplish this with as little discomfort to the patient as

possible. The fear and dread of an operation is usually caused chiefly by the fear and dread of the anæsthetic. Anoci-association is certainly the ideal method because the administration is unknown to the patient. This plan can be carried out in many ways since the use of the barbital preparations. Given by mouth or by enema an hour before the patient is to leave his room, they will bring about profound sleep which will last for several hours. When recovery occurs, much of the acute soreness may have subsided so that in every way this anæsthetic adds to the comfort of the patient, and anything that will accomplish this also adds to the development of the art of surgery.

#### ASEPSIS

Asepsis is the foundation of surgery. It not only opened the way for the further development of the art but it also established surgery as a science. Lister announced the principles of antiseptics and asepsis about 20 years after the discovery of the first inhalation anæsthetic. Since that time much has been accomplished toward the elimination of infection. This has been brought about by preparation of the patient before operation, by proper sterilization of all materials that are to be used, and by the knowledge gained in methods for preparing the hands of the operators and assistants. Just as the surgeon is responsible for the anæsthetic, so is he responsible for the asepsis which must exist in all mate-

rials that are to come in contact with the wound. The principles of asepsis are not all definitely established yet, for, in spite of all precautions, occasionally an infection occurs that is unexplainable. Some condition within the patient may be responsible. Not always are these unexpected infections due to contamination. The progress in development of the art has eliminated all but a very few sources of infection.

#### UNITY OF ART AND RESEARCH

This progress must continue, along with progress in research, and men must learn to use their hands and must teach others to do so in order that the surgical art may be carried on. Many of the keener minds in the medical profession are being attracted by research and rightly so. However, there should be and is the best opportunity for research for those who are closely in touch with practical medicine and surgery. The results of research and scientific studies carried on by persons with this two fold interest are likely to be of greater value than those prosecuted by persons who have lost touch with patients.

Perfection of the art of surgery can be obtained only by constant practice, and only those who are willing to spend much time and effort in the development of this sort of craftsmanship, along with their studies of the science of medicine, will have an opportunity to become the real artists of surgery.

# CLINICAL SURGERY

FROM THE ST LOUIS UNIVERSITY SCHOOL OF MEDICINE

## VAGINAL HYSTERECTOMY UNDER LOCAL ANÆSTHESIA<sup>1</sup>

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THE comparative study of anæsthetics for surgical operations has definitely established the fact that local anæsthesia is safer than inhalation narcosis and that of the various forms of local anæsthesia infiltration anæsthesia is the simplest and safest.

Contrary to the general surgeons gynecologists have been rather slow in drawing practical conclusions from these facts and only in the last year or two reports largely from foreign clinics are accumulating which reflect the advantages of local anæsthesia in gynecology and confirm the experiences of earlier workers (Ruge, Phaler, Farr, Hertzler, Allen, Frigyesi and others) in this field.

Supplementing my own observations published in 1913 and 1927 I now wish to call particular attention to the use of local anæsthesia in vaginal hysterectomies.

Local anæsthesia consists of two components, namely (1) a preliminary 'twilight sleep' and (2) infiltration of the parametria.

The pre-operative administration of morphine and hyoscine is essential in order to allay the very natural apprehensiveness of the patient and what is even more important to make it possible for her to endure the otherwise intolerable discomfort of the lithotomy position in which she is being operated upon.

The standard fluid for the infiltration is one half per cent novocain in normal saline solution, with adrenalin, 3 drops to the ounce. *In the last 3 months however, the strength of the novocain solution has been reduced to one-fourth per cent with equally good anæsthetic effect.*

The technique of parametric infiltration is quite simple. The cervix is grasped with a tenaculum in either lip and gently pulled down and to one side (Fig. 1). Into the lateral fornix thus unfolded the needle of the syringe is inserted parallel with, and alongside to the edge of the cervix to a depth of  $1\frac{1}{2}$  inches. The direction of the point

of the needle, therefore is a trifle lateral. A resistance encountered indicates that the needle has entered the wall of the uterus, the needle must then be pulled back a little and reinserted. It requires but very little experience to know when the needle is in its proper place in the soft tissue of the parametrium. Thirty cubic centimeters of the  $\frac{1}{4}$  per cent solution are now injected *while the needle is slowly withdrawn*. The procedure is next repeated on the other side. Figure 2 shows diagrammatically how by this infiltration of the parametria the nerve supply of the uterus, in particular the large sympathetic ganglion of Frankenhaeuser near the upper end of the cervix, is effectively blocked.

After the two injections it is essential to wait 5 minutes for the anæsthesia to become complete. A few cubic centimeters meanwhile injected into the space between cervix and bladder, and cervix and rectum respectively serve to render subsequent dissection much easier. The marked blanching of all the tissues which have been injected guarantees not only painless but also bloodless operating.

Two possible complications which however are easily prevented, may at once be mentioned. The needle may enter a blood vessel and the fluid be thrown direct into the circulation. The result would be a collapse. This danger can be avoided by testing through pull on the piston whether the needle has perforated a vein and by injecting slowly and *always* with the needle in motion. The possibility of perforating the ureter need not be considered if the needle has been inserted close to the edge of the cervix.

Another danger may arise from the breaking off of a needle. Steel needles rust easily and break off at the hilt. It is, therefore important that the needle should not be inserted its full length so that, if it should break off, it can be extracted without difficulty.

The technique of the hysterectomy itself is, with a few modifications, based on the two

<sup>1</sup>J. Am. M. Ass. 1913 Lx 1354 Surg. Gynec. & Obst. 1927 xlv 105

<sup>2</sup>Read at a meeting of the American Gynecological Society, Hot Springs, Virginia, May 21, 1932

TABLE I—INDICATIONS FOR OPERATION

	Cases
Prolapse	18
Cancer of cervix	13
of corpus	7
of vagina (primary)	1
of ovary	2
Chorionepithelioma	1
Tuberculosis of cervix and tubes	1
of lungs, metrorrhagia and rectocele	1
Fibroids of uterus	11
with sarcoma	1
Retroflexion with descent and subinvolution	5
with cystocele and rectocele	7
with climacteric bleeding	1
fixed with fibrosis	1
Climacteric bleeding (precancerous?)	6
Sampson cyst, rectocele	1
Ovarian cyst with subinvolution	1
with uterine polyps	1
Missed abortion with deep cervical tears	1
Adenoma uteri	1
Metrorrhagia of 1 year's standing	1
Total	92



Fig 1. Cervix pulled down and to one side. Needle of syringe inserted close to, and parallel with, the cervix.

suture method" designed by R. L. Dickinson<sup>1</sup> and consists of the following steps

1 For each side a long (20 inch) suture of chromic catgut No. 1 or 2, double, knotted, on a strong, non-cutting Mayo needle, is selected

2 The cervix is circumcised, the bladder is pushed off from the cervix and, laterally, from the base of each broad ligament, and both the anterior and posterior cul de sacs are opened

3 The long suture encircles the lowermost portion of the broad ligament and includes the sacro uterine ligament. After it has been tied, the needle anchors this suture to the adjoining vaginal wall in the manner indicated in Figure 3. The end of the suture is secured with a clamp

4 Cervix and stitch are pulled in different directions, and a cut is made between. The needle now bites through the next higher part of the parametrium, the suture is looped *twice*, carefully nestled home, and kept taut by the assistant (Fig. 4). This prevents not only slipping of the suture but also serves as retractor. The second cut usually takes us close to the uterine artery. The climbing upward on the broad ligament by doubly looped suture and cuts is continued as long as the uterus follows the pull easily. When the round ligament appears, it is caught by the needle and secured in the same manner (Fig. 5)

5 The opposite side is treated in the same fashion. Finally, the uterus is attached only to the ovarian and infundibulopelvic ligaments. The tubes and ovaries are left, if desired, or removed by using the final sweeps of the continuous

suture. Sometimes it will be found more expedient to apply a clamp temporarily to these uppermost structures and replace it by the suture after the uterus has been cut free. One must be careful to puncture and grip good tissue, to prevent slipping, for example in the infundibulo pelvic ligament. Care must be taken to hold the climbing suture at all times taut lest the ligated blood vessels slip out of the slack.

6 The uterus having been removed with or without adnexa, the free end of the suture with the needle attached is not cut, but tucked away for the moment (Fig. 6). The peritoneal cavity is now closed by a purse string suture (Fig. 7) whereby the stumps of the broad ligaments are placed extraperitoneally.

7 The anterior vaginal wall is next separated from the bladder by blunt scissors dissection (Fig. 8) and suitably resected, if redundant. The needle with the free end of the continuous broad ligament suture is thrust through the vaginal wall near the upper angle of the wound on either side (Fig. 9). When these two sutures are tied, the broad ligaments are not only in apposition, but they have also pushed the bladder backward and out of the way. They are now interposed between vagina and bladder, and their apposition is made even more secure by a few interrupted sutures which at the same time approximate the vaginal wound edges (Fig. 9). The lowermost ends of the broad ligaments which were anchored to the vagina at the beginning of the operation (Fig. 3), are now brought together merely by tying the knotted sutures.

<sup>1</sup>J. Obst. & Gynaec. Brit. Emp. 1913

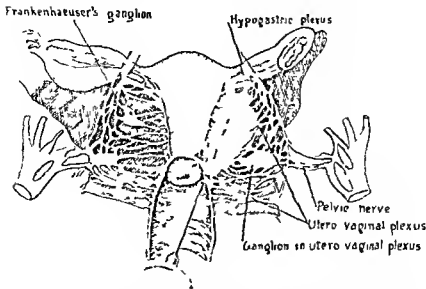


Fig 2 Diagrammatic picture of the nerve supply of the uterus The anæsthetizing fluid deposited in the parametrium effectively blocks all nerve impulses

8 A small rubber dam drain is sewed into the space between bladder and rectum (Fig 10) It will slip out after 10 or 12 days when the catgut is absorbed The rest of the wound is closed with one or two interrupted sutures

This in general, is the plan of the operation Occasionally slight additions or alterations are needed A narrow vaginal outlet requires a Schuchardt incision, a relaxed pelvic floor a perineorrhaphy A uterus too large to be removed in the manner described may have to be made smaller by bisection or morcellation, or the fundus may have to be luxated outward before the interlocking sutures can be applied to the upper portions of the broad ligaments In cancer of the cervix, finally the technique of the radical operation of Schauta requires the removal of a vaginal cuff I have elsewhere<sup>1</sup> described the details of this procedure Such variations necessitated by the exigencies of an individual case are part and parcel of any operative method

The effect of the local anæsthesia is very impressive throughout the operation Circumcising the cervix and cutting through the parametrium is entirely painless As the uterus follows the pull of the tenacula and direct traction is exerted on the round and infundibulopelvic ligaments, some pain is experienced in a certain percentage of the cases Fortunately, this pull is of very short duration, as the adnexa are quickly re-

moved, and the pain can be greatly reduced by the *steady and gentle* traction of an intelligent assistant A glance at Figure 2 which is taken from the work by Kuntz on the *Autonomic Nervous System*<sup>2</sup> shows that the parametric infiltration does not block out the nerve supply of the *upper* parts of the broad ligaments, and additional injections into these structures at this moment have no anæsthetizing effect This is probably due to the fact that the pull on the ligaments also involves the parietal peritoneum which is highly sensitive as we know from the fundamental researches of Lennander At any rate, there is no reason to let the patient suffer We can easily tide her over this short period of discomfort by a whiff or two of gas or ethylene or a few drops of ether, and this minimum and altogether harmless quantity of inhalation narcosis in no way vitiates the advantages of the local anæsthesia The remainder of the operation, that is the closure of the peritoneum, the interposition of the broad ligaments, and the approximation of the vaginal wound, is again entirely painless

In the manner described I have operated on 82 patients Vaginal hysterectomies performed with other forms of local anæsthesia (spinal presacral) or carried out by other members of the staff have not been included in the series here presented

The indications for operation are shown in Table I

<sup>1</sup>Surg Gynec & Obst 1913 xvi 284

<sup>2</sup>Lea & Febiger 1909



Fig 3

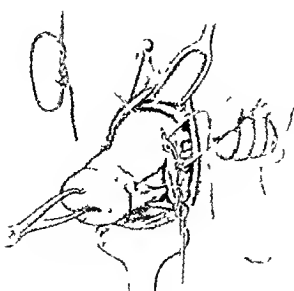


Fig 4

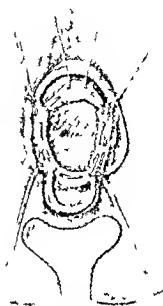


Fig 7



Fig 5

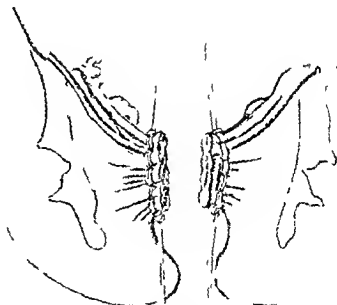


Fig 6

Fig 3 The cervix has been circumcised and the bladder and rectum have been pushed off from the uterus. The first stitch which passes through the lowermost portion of the parametrium is being anchored to the adjoining vaginal wall.

Fig 4 The suture climbs upward in the parametrium and is held taut at all times to prevent slipping. Note the double loop.

Fig 5 Diagrammatic picture of the blood supply, securely ligated by the continuous suture (Redrawn from Dickinson)

Fig 6 The stumps of the broad ligaments after removal of the uterus (Redrawn from Dickinson)

Fig 7 The stumps of the broad ligaments are pulled downward and outward, and the peritoneal cavity is closed by a pursestring suture.

Table II gives a survey of procedures carried out in connection with the vaginal hysterectomies.

In Table III the systemic complications encountered, are listed.

The effect of the local anesthesia is shown in the following table.

Table IV bears eloquent testimony to the value of local anesthesia. In 54 cases, or 64.6 per cent, the entire operation could be carried out without the slightest sensation of discomfort on the part of the patient. In 26 cases, or 31.7 per cent, the anesthesia was excellent, and only very

occasionally was a small amount of general narcosis added for humane reasons in order to tide the patient over the pull on the ligaments or to ease the strain of the lithotomy position. Even the most minute quantities of inhalants have here been listed, as for instance 20 drops of ether by actual count in one case and three whiffs of ethylene in another. Only in 3 cases, or 3.6 per cent, did the local anæsthesia prove insufficient and a general narcosis had to be given through the greater part of the operation, but even here the quantity of the general anæsthetic remained far below that ordinarily required. In these three instances the twilight sleep for unknown reasons, was incomplete.

In this series of 82 operations, 3 patients died. Of these a woman of 63, with a total prolapse and a third degree tear made a normal recovery from the operation but died, 7 days later from a parotitis. The second patient 71 years old had a cancer of the body which, during operation, was discovered to be too far advanced for complete removal, she died after 2 days, from anuria. Only in the third case that of a woman of 49 with a cancer of the cervix was the fatal outcome directly connected with the operation. A rather large pre operative dose of radium was probably the cause of considerable bleeding which made the radical Schauta operation on the next day extremely difficult. At autopsy, 4 days later, both ureters were found to have been ligated. The mortality in the present series, therefore amounted only to 1.2 per cent.

In the remaining 79 cases the signal advantages of the vaginal hysterectomy in local anæsthesia were in full evidence. During operation, the infiltration of the tissues rendered dissection both easy and bloodless. The operative technique employed safeguarded against the slipping of ligatures and consecutive bleeding. The operative field was at all times in full view and readily accessible, and no cut was made until all vessels had been secured. The operations, therefore were practically dry. Shock was conspicuous by its absence either during or after operation. The well known experience that the bodily resistance is but little affected by vaginal operations was again confirmed and the employment of local anæsthesia still further reduced the strain. The patients did not appear to have gone through a major operation. As a rule, they slept soundly for a number of hours and rarely complained of pain afterward. Postoperative discomfort was more often due to the perineorrhaphy which, as seen in Table II, was performed in one half of the cases. As there was no nausea or vomiting,

liquid nourishment could be given almost from the beginning, and the ordinary postoperative sequels, in particular gas pain were quite insignificant. The pulse was hardly ever affected. The temperature, on the other hand remained somewhere between 99 and 100 for several days in a good many instances without influencing the subjective well being. It may be that the subfebrile temperature is due to the fact that the operation is carried out in a non aseptic field.

The list of actual postoperative morbidity was small as seen in Table V.

The usefulness of local anæsthesia in vaginal hysterectomies is particularly marked when we consider the systemic and other complicating conditions encountered in the present series. These were listed in Table III. It is obvious that diabetes pulmonary tuberculosis, and cardiovascular disease would contra indicate any inhalation narcosis whereas these complications presented no difficulties to the employment of local anæsthesia. Patients with hypotension or hypertension fared equally well and systematic blood pressure examinations during operation showed no changes of any kind. Old age, in itself a grave complication in any operative procedure ceases to be a deterrent factor when an otherwise necessary operation can be carried out in local anæsthesia. The oldest patient in my series, a woman of 76 years passed through an uneventful convalescence. This leads to an enumeration of the age incidence in my patients.

In this table only the first group requires comment. These women who belonged to the laboring class were without exception, mothers of large families and presented a multitude of sequels of indifferent obstetrical care, such as prolapse, deep cervical and perineal tears, cystocele and rectocele, subinvolution, enteroptosis etc. A case in point is that of a woman barely 37 years of age, who has had seven children, of whom six are alive. Another patient, 33 years old, had given birth to twelve children. The saddest instance, perhaps, was a woman, not yet 30 years old, who already had six children and now came to the hospital with a missed abortion. She had an enormous cystocele and an old perineal tear of second degree and the cervix was torn on both sides up to the internal os. These three patients and most others in this group were worn out physically and mentally and seemed senile rather than women in their prime. In every case the choice between repair and vaginal hysterectomy was carefully explained both to husband and wife. Of course, the radicalism practiced in this particular class of cases, would be unjustifiable if the vaginal

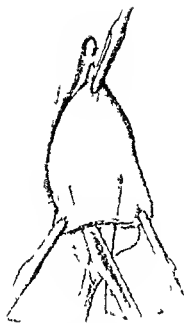


Fig 8

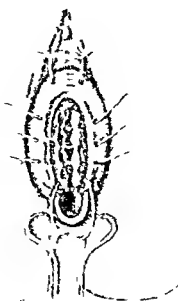


Fig 9



Fig 10

Fig 8 The anterior vaginal wall is held taut with clamps, dissected from the bladder and then suitably resected.

Fig 9 The broad ligaments are interposed between vagina and bladder.

Fig 10 The vaginal incision is closed with a few interrupted sutures and a small rubber dam drain is sewed into the space between the bladder and the rectum, and is secured with a catgut stitch.

hysterectomy were more dangerous than conservative procedures. But this is not the case, and the perfect safety of vaginal hysterectomy under local anæsthesia fully authorized this extension of the operative indication.

For the same reason vaginal hysterectomy under local anæsthesia is qualified to supplant the Watkins Wertheim interposition operation which has its very definite drawbacks. In tuberculous women the problem of operative sterilization is probably better served by this operation than by any other method, and I find that only recently Hornung, of Stoeckel's clinic in Berlin, has stressed the same point.

Some 30 years ago, Dührssen maintained that every woman of 45 years should have her uterus removed. At that time such a position was indefensible, but at any rate it had this nucleus of truth that such a radicalism was the best prophylaxis against uterine cancer. Today the safety and simplicity of the operation if done under local anæsthesia, permits us to carry out a more active prevention of cancer. Accordingly, as seen in Table I I have in 6 cases of climacteric bleeding performed hysterectomy rather than exploratory curettage and thereby protected the patients once and for all from the possibility of malignancy. Incidentally, I found in one of these extirpated uteri an extensive leucoplakia, a metaplasia of the epithelium, formerly called psoriasis

uteri, which is generally considered a forerunner of carcinoma. Those to whom this procedure is new and, therefore, alarming, should bear in mind that a vaginal hysterectomy under local anæsthesia is in its effect on the patient little more than an ordinary curettage.

Yet, I would not wish to create the impression that the operation should be undertaken without proper preparation and in every case. The question of diagnosis is of prime importance. The man who has to open the abdomen "to see what is in it" is hardly equipped to embark on a vaginal hysterectomy. Certain conditions are definitely unsuited for this operation. The observant reader may have noticed that the list of operations contains not a single case of inflammatory disease. If such affections are operated on at all, they should be attacked by an abdominal operation, for peritoneal adhesions in general contra-indicate the use of local anæsthesia and render the vaginal hysterectomy extremely difficult. The beginner should select his initial cases with great care and start on prolapsed uteri which follow the pull of the tenacula easily. He should also provide himself with the right sort of instruments, in particular good vaginal retractors which will satisfactorily expose the operative field. For the general surgeon the operation is, probably, too difficult, as may be inferred from statements made by Farr, Hertzler, Allen, and



TABLE II—PROCEDURES CARRIED OUT WITH VAGINAL HYSTERECTOMIES

	Cases
Perineorrhaphy	41
Third degree tear	2
Le Fort operation	2
Bilateral removal of adnexa	6
Unilateral removal of adnexa	8
Schauta's radical operation for cancer of cervix	13
Ovarian cyst	2
Removal of rectal polyp	1
Total	75

TABLE III—SYSTEMIC COMPLICATIONS

	Cases
Diabetes	3
Pulmonary tuberculosis (active)	2
Cardio renal	11
Bronchitis	1
Hypotension (100 or less)	4
Hypertension (180 or more)	22
Total	43

TABLE IV—EFFECT OF LOCAL ANÆSTHESIA

	Cases	Cases
Perfect		53
Good with occasional ether	6	
nitrous oxid	12	
ethylene	8	26
Insufficient requiring ether	1	
nitrous oxid	1	
ethylene	1	3

others, but to the modern gynecologist who knows the anatomy and is familiar with the approach from below, vaginal hysterectomy under local anæsthesia will prove a highly satisfactory and, in time, easily accomplished procedure. This operation, it is true, makes great demands on the physical stamina of operator and assistants, but the gratifying effect on the patient will compensate for the energy expended.

## SUMMARY AND CONCLUSIONS

Vaginal hysterectomy can readily be performed under local anæsthesia by which the parametria are infiltrated with a 1/4 per cent novocain solution. The special technique employed in the hysterectomy is a modification of Dickinson's "two suture method." The details of both procedures are described and depicted in this paper. Performed under local anæsthesia, vaginal hysterectomy entirely loses the character of a major operation, the whole procedure is practically bloodless and almost always completely painless, the strain upon the patient's resistance is hardly more than that of a curettage or minor plastic operation. For this reason, systemic complications such as diabetes, active tuberculosis, or

TABLE V—ACTUAL POSTOPERATIVE MORBIDITY

	Cases
Breaking down of perineorrhaphy	6
Cystitis	3
Pyelitis	2
Vesical fistula	2
Coccygodynia	1
Total	14

TABLE VI—AGE INCIDENCE

	Cases
30 to 39 years	15
40 to 49 years	39
50 to 59 years	17
60 to 69 years	8
70 to 76 years	3
Total	82

cardiorenal disease which contra indicate any general narcosis or, as in the case of old age, render any operative intervention extremely hazardous, are no bar to vaginal hysterectomy, if local anæsthesia is employed.

The series here presented comprises 82 hysterectomies, of which the greater part was performed for prolapse, cancer, and fibroids. The less frequent indications are listed in a table. Other tables show the number of other operative procedures carried out simultaneously with the hysterectomy, the various sorts of systemic complications, the very small number of postoperative disturbances, the age incidence. The oldest patient in the series was 76 years old and had an undisturbed convalescence.

Of the 82 patients 3 died, but only in 1 case was death caused by the operation, or rather a fault in operative technique.

The safety of the operation itself is so great that it permits of an extension of the usual indications, as is discussed at length in the paper. This opens up new fields for the usefulness of vaginal hysterectomy.

Of course, the technique of both the operation and the local anæsthesia has to be acquired, special instruments must be employed, and the cases which are suited for local anæsthesia, must be properly selected. This is pre eminently a purely gynecological operation, which will present no unusual difficulties to the modern gynecologist who knows the anatomy and is familiar with the approach through the vagina—an operation, moreover, which presents such signal advantages that he should be glad to adopt it in the interest of his patients.

NOTE.—Since the foregoing was written I have performed 9 additional hysterectomies. All patients recovered from the operation. In 8 the local anæsthesia was perfect in 1 it was insufficient. The total number of cases in the present series is now 91.

## FROM THE GYNÆCOLOGICAL DEPARTMENT, ROTUNDA HOSPITAL

## THE TECHNIQUE OF TOTAL HYSTERECTOMY

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IN visiting various clinics one is struck most forcibly by the different techniques adopted by gynecologists for the operation of total hysterectomy. In spite of the marked increase in the use of radium and X-rays for the treatment of uterine bleeding, there are many such cases where in addition to the hæmorrhage, the cervix is involved either in ulceration, erosion, ectropion, or some similar condition, so that hysterectomy is necessary and advisable.

For this type of case the subtotal operation is out of the question. Many of the patients who require total hysterectomy, are desanguinated, and it is necessary to adopt a technique in which there will be no hæmorrhage, where the operation is speedy, and at the same time where complete peritonealization is carried out.

The technique described below has been carried out by the author at the Rotunda Hospital and in private practice, with complete success for some years, and no complications have followed it.

The patient is given a preliminary "twilight sleep" as follows—morphine  $\frac{3}{4}$  grain and scopolamine hydrobromide  $\frac{1}{100}$  grain are given one and a half hours before operation, morphine  $\frac{1}{6}$  grain and scopolamine  $\frac{1}{200}$  grain half an hour before operation. The patient is then brought to the anæsthetic room, where ephedrine  $\frac{1}{2}$  grain is administered. The blood pressure is taken, and if 130 millimeters mercury or more, the subcutaneous tissues are injected with  $\frac{1}{2}$  per cent novocain. The spinal needle is then inserted intrathecally between the fourth and fifth lumbar vertebra. One cubic centimeter of spinal fluid is withdrawn and mixed with 1 cubic centimeter of 5 per cent stovaine in glucose, which is already in the syringe. Unless the tumor reaches far above the umbilicus, the anæsthetic is perfect, occasionally, however, a little open ether is necessary, and is given. Before the operation is commenced, the vagina is plugged well up to the cervix with iodoform gauze soaked in 3 per cent picric acid, and the end left well out of the vagina.

## STEPS OF THE OPERATION

After painting the skin with 3 per cent picric acid in 90 per cent alcohol, the abdomen is opened, and the skin and skin edges are protected by

dressings. The first part of the operation consists of cutting and tying the infundibulopelvic and round ligaments, and pushing down the bladder. Clamps control bleeding from the ovarian arteries on the uterine side. The uterosacral ligaments are then cut without ligating, and the posterior peritoneum is pushed down. The rectum never appears unless there are adhesions. At this stage an assistant removes the gauze in the vagina. The uterine vessels on either side are caught in a curved clamp. A small cervix needle is passed parallel to the long axis of the uterus, and the uterine vessels are ligated (Fig 4). Mackenrodt's ligaments are caught in a straight forceps (Fig 5). A small cervix needle is used again, containing a stitch which is placed around the ligament and acts as a second safety ligature for the uterine vessels (Fig 7). The vaginal angle is then caught in a curved forceps. This is an absolutely safe procedure, and there is no risk in including the ureter for the forceps is kept closely applied to the uterus (Fig 8). A stitch is then placed

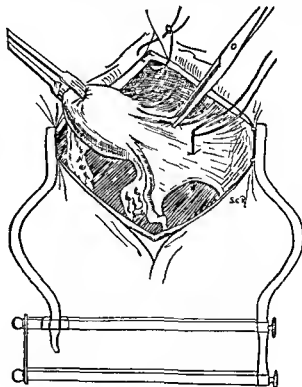


Fig 1 Ligation of ovarian vessels

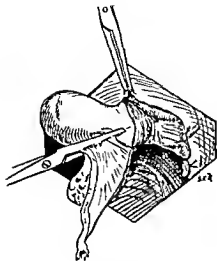


Fig 2

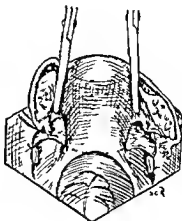


Fig 3

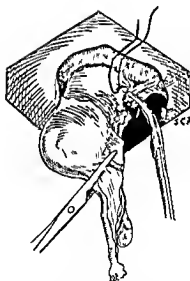


Fig 4

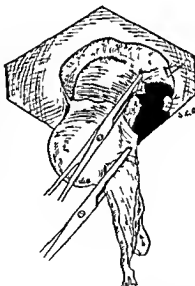


Fig 5

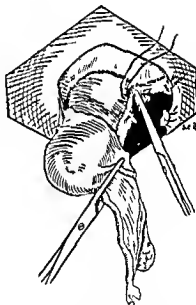


Fig 6

Fig 2 The ovarian vessels and the round ligament on the right side are controlled by clamp

Fig 3 Line of section of uterosacral ligaments

Fig 4 The uterine vessels of the right side are clamped and ligated

Fig 5 Mackenrodt's ligaments are clamped by straight forceps

Fig 6 Suturing Mackenrodt's ligaments with a small cervix needle. The suture acts as a second safety ligature

round this, and tied (Fig 9). When all these sutures have been placed, the uterus is ready for removal. The anterior vaginal wall is cut across and iodoform gauze is passed into the vagina. This pushes down any septic matter which may have been present. The gauze is left long temporarily (Fig 10), and if after the removal of the

uterus there is any oozing or any 'spill' it is packed in the parametrium and the pelvic peritoneum sewed over it. In most cases, however, it is cut short and drawn through the vagina. The incision in the vagina is continued until it is completely cut across and then sutured. This is done with a modified I embert suture which in

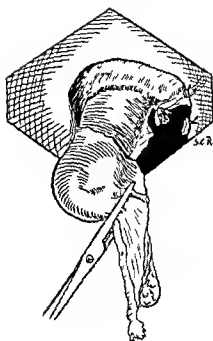


Fig. 7

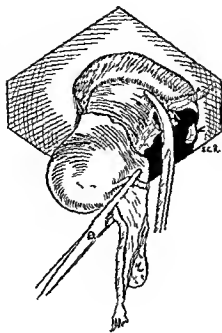


Fig. 8

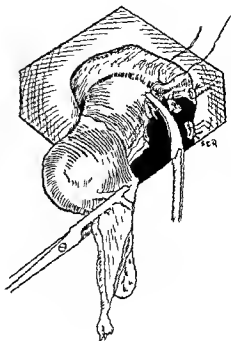


Fig. 9

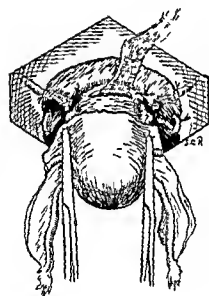


Fig. 10

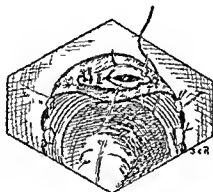


Fig. 11

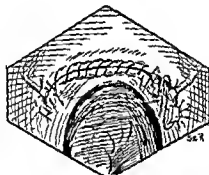


Fig. 12

Fig. 7 The suture around Mackenrodt's ligament also surrounds the uterine vessels

Fig. 8 Clamping vaginal angle

Fig. 9 The vaginal angle has been caught in a curved forceps and a suture is being passed

Fig. 10 The anterior vaginal wall has been incised—gauze pushes down any discharge from the vagina

Fig. 11 Closure of vagina by Lembert suture

Fig. 12 Peritonealization of pelvis

folds the edges and brings raw surface to raw surface. This must be done with care, otherwise the vaginal walls may become separated. The pelvic peritoneum is then closed by a continuous suture

from right to left. This suture buries the stumps and causes complete peritonealization.

My thanks are due to Dr. Stella Henry for the illustrations accompanying this communication.

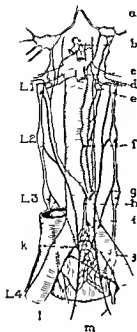


Fig 1 Connections of the presacral nerve *a* semilunar ganglion *b* coeliac plexus *c* superior mesenteric artery *d* renal plexus *e* renal ganglion *f* inferior mesenteric artery *g* middle root of presacral nerve *h* left lateral root of presacral nerve *i* presacral nerve *j* branch from third lumbar ganglion *k* branch from fourth lumbar ganglion and *l, m*, hypogastric nerves (after Lauer)

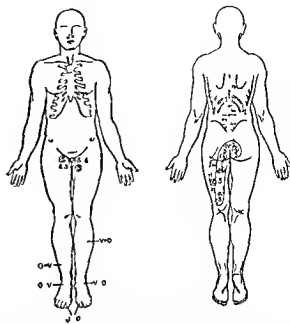


Fig 2 The sensory disturbances in the case reported. Touch designated by Arabic numerals; pain by Arabic numerals in circle; temperature by Roman numerals; vibration by I

reaction which lasted 48 hours. The residual urine on 3 successive days amounted to 300, 195 and 195 cubic centimeters respectively.

Operation was performed December 20, 1929, a left paramedian incision was made. The cecum and small bowel were packed upward and to the right, and the sigmoid colon was drawn firmly over to the left. The bladder was noted to be large and flabby, although the patient had been catheterized immediately before operation. The rectum was not dilated. The main trunk of the presacral nerve was easily visible under the peritoneum over the left common iliac vein. The peritoneum over the fifth lumbar vertebra was opened in the middle line and this incision was extended upward and downward to a length of 8 centimeters (Fig 3). The presacral nerve was first isolated at its lower end, and the branches joining it from the fourth lumbar ganglion were divided. The nerve was cut across just beyond the origin of the two hypogastric nerves and ligatures were placed on its distal ends to control bleeding from the vasa nervorum. By upward traction on the proximal end of the nerve the branches joining it from the third lumbar ganglion were put on the stretch and were divided. Finally the lateral roots were severed on each side, the segment of nerve measured 50 centimeters in length (Fig 4). The wound in the posterior peritoneum was closed and the abdominal incision was sutured in layers.

At first the bladder was allowed to drain continuously through an indwelling catheter, a daily lavage was given with a 1:5,000 solution of potassium permanganate. During this period of drainage an attempt was made to stimulate the musculature of the bladder and to reaccustom it to

contraction by the intramuscular administration of acetylcholine, a proprietary preparation containing acetylcholine in stable form. The drug is a specific stimulant of those structures innervated by the sacral autonomic outflow, just as epinephrine is a specific stimulant of those structures innervated by the thoracolumbar sympathetic outflow. It was given twice daily in doses of 0.10 grams dissolved in distilled water. Its efficacy in promoting contraction of the bladder may be judged from inspection of a cystometrogram (Fig 5).

December 29, a clip was placed on the indwelling catheter, the clip was opened at lengthening intervals until January 1, 1930, when the catheter was removed. The patient at once began to pass urine in amounts of about 100 cubic centimeters, and was emphatic in stating that the act was much more easily performed than before operation. Therefore, it was somewhat discouraging to find at the end of the day 800 cubic centimeters of residual urine. Unfortunately, convalescence hitherto most uneventful was complicated on the following day by the development of severe right epididymitis with retention of urine. At first intermittent catheterization was employed and January 7 this could be limited to one instrumentation each day. January 7 residual urine was 270 cubic centimeters; on successive days thereafter it was respectively 240, 210, 330, 180, 255, 215, 300, 270 and 300 cubic centimeters. January 17, an indwelling catheter was reinserted and 0.10 grams of acetylcholine was given intramuscularly twice daily. Under this treatment, together with local applications, the epididymitis subsided and on January 25 the catheter was removed. Daily tests showed that the residual urine, January 26, was 150 cubic centimeters; January 27, 30 cubic centimeters; and January 28, none. The condition of the urine improved greatly, and by January 27 the amount of albumin present was graded 1, and the urine was microscopically normal.

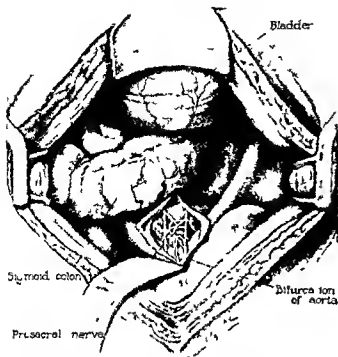


Fig 3 Exposure of the presacral nerve. The plexiform arrangement of the nerve has been reproduced, as this arrangement is found in 80 per cent of cases.

A postoperative examination, January 6, had disclosed the same neurological features as before operation. A final cystoscopic examination was made February 5. There was no residual urine. The internal sphincter was relaxed as before. Sensation was still much diminished. The cystitis was subsiding. The striking feature was the fact that after the introduction of 450 cubic centimeters of water the expulsive power of the bladder was considered by the cystoscopist to be nearly normal, although a cystometrogram made 2 days previously would not have led one to expect this (Fig 5).

Clinically, the patient was still unable completely to empty the bladder while he was erect, but he recognized great improvement in expulsive power, and could empty it completely in a sitting posture. He could tell when the bladder was becoming full (after the introduction of 225 cubic centimeters of water), but still preferred to urinate voluntarily at regular intervals. Immediately after operation, while he was taking aperients, he had a little trouble in controlling the bowels, this was possibly to be expected, in view of the fact that the tonus of the internal sphincter of the anus is partly maintained by the presacral nerve through the hypogastric nerves. Rectal control, however, began to improve when he was up and about, so that he never soiled himself.

The features of the case may be summarized as follows: (1) injury to the intraspinal connections of the posterior roots of the second sacral to fifth sacral nerves on the left side, and third sacral to fifth sacral nerves on the right side, manifested by anaesthesia of the skin, and anaesthesia of the bladder, (2) injury to the intraspinal connections of the anterior roots of at least the third and fourth sacral nerves on both sides, manifested by



Fig 4 The nerves removed at operation. The presacral nerve was a single trunk. Above, on the right, are the branches joining it from the first and second lumbar ganglia, on the left, these branches are united to form one trunk. On each side are the branches joining it from the third and fourth lumbar ganglia. Below, the two hypogastric nerves may be seen leaving the presacral nerve.

paralysis of the external sphincter of the anus, and loss of expulsive power of the bladder, (3) relaxation of the internal sphincter of the bladder, which was not due to palsy of the hypogastric nerves, for these sprang from unaffected segments of the spinal cord (probably this was an expression of hypotonia, the result of injury to the synapses of a reflex arc, which reached the cord either by way of the pudic nerves or the pelvic nerves, and the posterior roots of the third and fourth sacral nerves), and (4) complete control of the compressor urethrae muscle in spite of the injury to the intraspinal connections of the anterior roots of the third and fourth sacral nerves, the internal sphincter was functionless.

The most striking feature was the integrity of those fibers from the third and fourth sacral anterior roots which innervated the compressor urethrae muscle. Granted that the lesion was not a complete one, it is nevertheless surprising that the external sphincter was strong enough to insure complete continence of urine.

The decision to interrupt the thoracicolumbar sympathetic fibers to the bladder was reached only after much consideration. By this procedure, we hoped to place the detrusor muscle and its reduced motor nerve supply under the most favorable conditions for emptying the bladder, on the hypothesis that such nerve section would

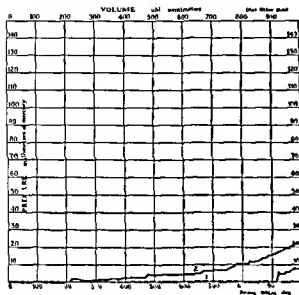


Fig. 5. Cystometric readings 1 5 weeks after operation although the cystometrogram shows evidence of an atonic condition of the bladder the patient was able to empty the bladder completely and cystoscopic examination showed good expulsive power. 30 minutes after 1 and 15 minutes after the intramuscular injection of 0.10 grams of acecholine the effect of the drug on the detrusor muscle is shown clearly.

interrupt impulses which inhibit the musculature of the bladder. There were many arguments however against such a hypothesis. Elliot, on structural and physiological grounds, considered it unlikely that the hypogastric nerves could inhibit the detrusor muscle in man. Again, even if inhibitory impulses pass along the hypogastric nerves of man it does not necessarily follow that they are continuous, or that they act as a brake on vesical contractions once initiated by the pelvic nerves. Further, in this particular case, a pertinent problem was the degree of reflex inhibitory activity (if any) mediated by the hypogastric fibers, for their motor function to the internal sphincter was in abeyance, as a result of deficiency in afferent paths, and it might well be asked whether their inhibitory influences also would be suppressed in the absence of complete information as to the tonus of the bladder. Finally, we were somewhat reluctant to sever the only intact path by which afferent impulses from the bladder could reach the spinal cord.

We could find no guidance in the literature. It has been observed (5) in goats that following lumbar ramisection by the extraperitoneal approach devised by Royle the expulsive power of the bladder is increased, and by this procedure

some, at least, of the sympathetic nerves to the bladder are interrupted. Moreover, although it played no part in the consideration of our case we derived some assurance only a few hours after the operation from chancing on a case presented to the Société de Chirurgie de Lyon by Richer, a summary of the details given by him follows.

A woman aged 50 years was suddenly seized with complete inability to urinate. Regular catheterization for a month did not improve the condition and she consulted Richer. He was impressed by the degree of dilatation of the colon which also existed but could not demonstrate colonic obstruction by barium enema. There was no evidence of tabes dorsalis or Pott's disease and no motor or sensory changes in the lower extremities. Spinal puncture showed lymphocytosis in the cerebrospinal fluid. Of 350 cubic centimeters of water introduced into the bladder the patient could pass only 50 cubic centimeters but after the hypodermic injection of 1 cubic centimeter of a 1 per cent solution of pilocarpine nitrate 250 of 350 cubic centimeters was passed with intense bladder colic. Richer divided both hypogastric nerves at the level of the upper border of the hypogastric ganglions. For 15 days a catheter was passed twice daily. On the fifteenth day the patient was able to pass 130 of 350 cubic centimeters of fluid. Three months later there was only 60 cubic centimeters of residual urine.

Finally we concluded that it was vitally necessary to deal with the residual urine, which constituted the risk to life and to accomplish this, if possible, without condemning the patient to a catheter life. We felt that by submitting to operation the patient might gain much, and would lose nothing and after the whole position had been frankly put before him, he readily agreed to this course.

We recognize that one case is insufficient from which to draw conclusions, although its clinical features were such that the operation was of the nature of an almost clean cut physiological experiment. Moreover, we realize that we were dealing with a bladder already partly freed from its central nervous connections that the neurectomy freed it from the controlling influence of still another "level" of the nervous system (as defined by Hughlings Jackson), and that it is necessary to be cautious in translating the effects we observed to explain the mechanism of physiological control of the normal bladder. Nevertheless, we feel that the extent of improvement in the expulsive power of the bladder, and the rapidity with which this made its appearance, must be attributed partly to the neurectomy. It has been our experience with this type of lesion, that when the bladder becomes atonic and a large amount of residual urine accumulates, in the majority of cases catheterization will not greatly reduce it. For this reason we usually introduce permanent suprapubic drainage rather than have the patient

forced to catheterize himself three or four times a day. It is true that occasionally, with early lesions of the central nervous system when antisyphilitic treatment has been thoroughly carried out, repeated catheterization will gradually reduce the residual urine over a period of several months, and in the exceptional case it may be completely eliminated. Reduction of urine, however, is gradual and extends over a long period of time.

The most reasonable explanation of the success of the operation seems to us to be that the hypogastric nerves in man do carry inhibitory impulses to the bladder, and that these impulses may be sufficient to prevent complete emptying of the bladder when the hypogastric nerves are intact, although the pelvic nerves are injured, as in our case. Further, the outpouring of inhibitory influences by way of the hypogastric nerves would seem to be independent of the outpouring of motor impulses to the internal sphincter and trigonal region. There is a possibility that the results of such sympathetic neurectomy will not be lasting, but we report the case in the hope that others who have similar suitable cases may be encouraged to try the method, and to place their experience on record.<sup>1</sup>

In selecting cases for the operation, we would emphasize certain requirements. The clinical data must point to reduction of the function of the pelvic nerves (aptly called by Rose the "emptying" nerves of the bladder), while the hypogastric nerves are uninjured, in other words, the balance of vesical innervation is disturbed, and injured pelvic nerves are handicapped in their task by the "brake" action of intact hypogastric nerves. As a corollary, there must not be total paralysis of the pelvic nerves, in order that after removal of the brake the residual expulsive power of the detrusor muscle may be more equal to emptying the bladder. Again, the patient must be continent, through the action of the compressor urethrae

muscle, for the hypogastric nerves are the motor nerves to the internal sphincter. Finally, there must be satisfactory renal function.

#### SUMMARY

A case of cord bladder is described in which both pelvic and pudic nerves were partly paralyzed.

An operation is described, by which the thoracolumbar sympathetic supply to the bladder was interrupted.

In view of the part played by this operation in eliminating residual urine, the possibility is raised that the hypogastric nerves carry inhibitory influences to the bladder.

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<sup>1</sup>Seven months after operation we had a report from this patient stating that he could urinate freely in any position and that repeatedly catheterization had shown that there was no residual urine. This leads us to hope that the beneficial effect of the operation will be permanent.



## SARCOMA OF THE CERVIX

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UTERINE sarcoma was first described by C. Mayer, in 1860, and later confirmed by Virchow in 1867. In 1867, G. Veit devoted a portion of a chapter in his work upon diseases of women to the affection describing 3 cases of his own, including 1 case of sarcoma of the cervix which was the first on record.

According to Kelly, sarcomata, in general, constitute about 2 per cent of all uterine tumors or about 5 per cent of all malignant neoplasms. While most of the uterine carcinomata originate in the cervix, the opposite holds for the sarcomata where but one out of five occurs in this locality.

The literature consists almost entirely of case reports. Bettinger, in his thesis, in 1909 mentions 33 cases which he collected from the literature in reports by 30 authors.

Piquand, in his treatise on sarcoma of the uterus, divides sarcoma of the cervix into two groups: (1) Racemose sarcoma, characterized by the fact that macroscopically the tumor resembles a bunch of grapes and (2) all other varieties—a rather ill defined group. Up to 1905 Piquand had collected 29 cases of racemose sarcomata. These increase rapidly in size and soon fill the vagina, which may become considerably distended, and they may even herniate outside the vulva. There is an associated abundant discharge which is often fetid, although the tumor does not have any great tendency to ulcerate.

The same author also collected 41 cases other than racemose sarcomata. These tumors do not differ from sarcomata of the body, and two large classes are encountered: (1) sarcoma of the mucosa and (2) sarcoma of the parenchyma. Sarcomata of the mucosa are very much more common and they may be diffuse or circumscribed. The diffuse form is very rare. There is an ill defined infiltration, with thickening and vegetation of the mucosa, which is involved wholly or only in part. The tumor has little tendency to invade the body of the uterus, but frequently extends the other way, to the vaginal mucosa. In the beginning, the neoplasm is limited to the mucosa, but later it extends to the muscular tissue. The circumscribed sarcoma is the most frequent of all the sarcomata of the cervix. It may take the sessile or pedunculated forms.

The sessile sarcoma forms a sort of vegetative mass, more or less projecting over the cervix and resembling exactly a papillary epithelioma, from which it is differentiated macroscopically only by its soft consistency, its greater size, and its tendency to gangrene and suppuration.

The pedunculated sarcomata or sarcomatous polyps generally have the appearance of a rounded or pyriform tumor, joined to the cervix by a more or less contracted pedicle. The size is variable but rarely exceeds that of an orange. The pedicle is usually implanted in the cervical canal. Very unusually is it implanted on the external surface of the cervix.

Sarcomata of the parenchyma are rare; they always take the polypous form. Primary sarcomata of the parenchyma of the cervix have been noted (Grenser) but they are almost always due to a sarcomatous degeneration of a fibrous polyp. The tumor is rather regular in shape, smooth or bossed, its consistency is firm, but variable at different points.

Histologically round cell, spindle cell, and ramified cell sarcomata are found. Bowman's case was a giant cell sarcoma. The surface of the tumor is sometimes covered with a regular epithelial layer but when the sarcoma has existed for some time this covering has partially or completely disappeared (Bettinger). It should be noted that observers have quite frequently found the presence of heterotopic elements of cartilaginous tissue (Geisler), or of striated muscle fibers (Rudnewa, Kascherowa, Richter).

Sarcomata of the cervix always begin insidiously and may evolve for a long time before they are manifested by any functional symptom. The three leading symptoms are hemorrhage, pain and serous discharge, the same symptoms encountered in carcinomata. The average duration of life appears to be from one and a half to two years.

Metastases occur in the parametria, the vagina, the peritoneum, the lungs, the bony and the central nervous system.

The treatment should be the radical abdominal hysterectomy along the lines of the Wertheim technique. Most of the cases reviewed in the literature terminated fatally from metastases, yet, with earlier recognition of the disease, it might be possible to improve the results.



Fig 1 Cellular tumor of uterus extending into the mucosa on the left. On the right necrosis and acute inflammatory reaction X8

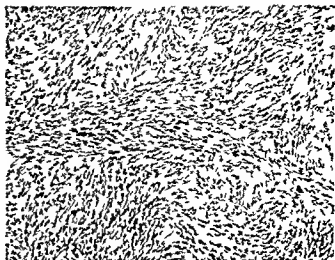


Fig 2 Bundles of spindle shaped cells running in different directions. Photomicrograph of section from the tumor of the uterus X70

#### SARCOMA OF THE CERVIX WITH METASTASIS TO THE OVARY

Miss M. F., a machine operator by occupation, was born in Massachusetts, 36 years ago. She was seen in consultation at the Leonard Morse Hospital on February 1, 1920. Her complaint was constant vaginal bleeding, without pain, since August, 1918. Her father, her mother, 3 brothers and 3 sisters were living and well, 2 brothers had died, 1 of pertussis, when 3 years of age, the other from a railroad accident at 21 years of age. There were no chronic diseases in the family. The patient had measles, pertussis, and scarlet fever as a child. In 1918 she had influenza. Eighteen years ago she had an appendectomy performed at the Leonard Morse Hospital. Four years ago she was in the same hospital for what was termed 'a heart condition'. Menstruation was established when she was 15, the periods were regular, of the 28 day type, lasted 6 to 7 days, requiring four napkins per day, there was pain across the pelvis lasting 2 to 3 hours after the onset and small clots were passed. Since August, 1918, she had been flowing constantly, she would have a regular period, stain for a few days, flow again for a day and repeat the process so that there was the daily appearance of blood. There was no pain, except for abdominal cramps at the time of the regular period. Her appetite was good, her bowels were regular, there were no urinary symptoms, and she did not think that she had lost in weight.

**Examination.** There was nothing remarkable noted except for the pelvic condition. The vaginal examination showed normal nulliparous external genitals. The cervix was large, indurated, eroded, bled freely to the touch, and contained a mass which extended laterally to the parametria. The uterus was hypertrophied and in the second degree of retroversion, the adnexa could not be felt easily because of the induration of the broad ligaments. The urine was normal and the blood examination was within normal limits despite the fact that she had had prolonged bleeding.

**Radium treatment.** On February 1, 1920 the cervix was inspected under ether anesthesia. A clinical diagnosis of carcinoma of the cervix (inverting type) was made, a biopsy specimen was obtained and 50 milligrams of radium sulphate in a Jefferson applicator covered with a millimeter of rubber was introduced in the cervical canal and

left *in situ* 36 hours, giving a radium dose of 1800 milligram hours. The vagina was tightly packed with gauze and a self retaining catheter was introduced in the bladder. On February 15, 1920, a deep X ray treatment was administered. The pathological report of the fragments obtained from the external os was sarcoma.

**Operation.** The patient had stopped bleeding after the use of radium, but there had been no appreciable reduction in the size of the tumor. Operation was decided upon and was performed on March 12, 1920. The intervention consisted of a radical abdominal hysterectomy with ligation of the hypogastric arteries. Under ether anesthesia a median incision was made from the symphysis extending through the umbilicus and about 2 inches above it, this incision was made partly through an old median scar. It was found that the uterine tumor filled the cervix and extended laterally. The parametria, although infiltrated, were accessible. The infundibulopelvic and round ligaments were ligated and cut close to the pelvic brim. The leaves of the broad ligaments were separated and the peritoneum was pulled upward exposing the common iliac arteries at their bifurcation. The hypogastric arteries were isolated and ligated, with silk, near their origin. The ureters were identified at this place. The bladder was separated from the uterus and vagina, it was firmly adherent because of the location of the neoplasm and because of the use of radium. There was considerable edema of the broad ligaments. The uterine arteries were next dissected and tied at their origin. The uterus was turned forward the uterosacral ligaments were clamped, cut, and tied, the rectum was separated from the vagina posteriorly, the ureters had to be dissected from the parametrical tissues by sharp dissection on account of the firm scar tissue in this region, they were then liberated up to their entrance in the bladder, the venous plexuses extending to the bladder horns, were clamped, cut, and ligated. After thorough washing off of the pelvis, the vagina was opened at a considerable distance below the mass, and the uterus and adnexa were removed. The vagina was closed by a figure of eight suture at each angle, leaving a central opening into which was introduced a small cigarette drain. The two layers of peritoneum anterior and posterior were united with a running stitch, thus covering over all raw areas. No chronic catgut was used throughout the operation. A large cigarette

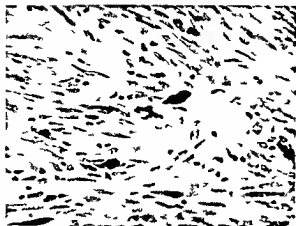


Fig 3 Tumor of uterus showing one multiple mitosis and several multinucleated cells  $\times 265$



Fig 4 Metastasis of tumor in ovary Tumor nodule in lower center Corpus fibrosum in upper right  $\times 8$

drain was placed in the cul-de sac of Douglas and allowed to come out at the inferior angle of the incision. The omentum was brought down and the incision was closed in layers. The duration of the operation was 1 hour and 17 minutes. She left the table with a pulse of 110 and showed no evidence of shock.

**Convalescence.** The patient made a good ether recovery. The temperature on the evening of the first day was 101 degrees F pulse 108 respirations 20. On the evening of the second day the temperature was 101 degrees F pulse 104 respirations 20 otherwise the temperature was normal the pulse in the vicinity of 80 and the respirations 20. The abdominal drain was removed on the fifth day and the vaginal on the seventh. The sutures were removed on the ninth day. The patient had to be catheterized every 8 hours during the 12 days she was in bed otherwise there were no complications. She was examined on the twelfth day after operation the incision was healed except for a small granulating wound in the drainage tract the abdomen was soft and there was no tenderness anywhere. On the thirteenth day she was allowed out of bed shortly after she voided normally. She left the hospital on April

2 1929 on the twenty first day after operation in excellent condition and was referred for deep X ray therapy.

**Pathological report.** The specimen was taken to Dr I. B. Mallory. The microscopic examination showed fibrosarcoma of the uterus with metastasis to the ovary.

On April 2 1929 an examination of the patient showed a well healed abdominal incision and no abdominal tenderness. The vaginal examination showed a healed vaginal vault and no bleeding to the touch. The rectal examination revealed no masses or areas of sensitiveness laterally. She was enjoying good health.

On July 2 1929 the examination was identical with the preceding one. The patient appeared in good health. Soon after she developed brain symptoms she was treated by an internist and by a neurologist. On August 14 1929 she died of what clinically seemed to be a metastasis to the brain. A post mortem examination was urged but refused.

This case presented many points of interest. The clinical diagnosis was that of carcinoma of the cervix because of the marked ulceration present. The biopsy performed before the introduction of radium made the histological diagnosis possible. Radium stopped the bleeding and healed the ulceration but had no appreciable effect on the growth itself. Operation was decided upon on account of this fact. The metastasis to the ovary had not been suspected even at operation and was proved with the microscope. In view of the ovarian involvement the chances of a cure with radium were greatly diminished. From the standpoint of technique the preliminary ligation of the hypogastric arteries near the bifurcation of the common iliacs was of marked value in saving blood and in expediting the operation. Because of the bloodless field, the ureters were dissected out of dense scar tissue in the paracervical regions, with no great difficulty. Despite the fact that no local recurrence could be found, the patient died of

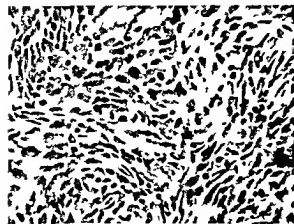


Fig 5 Metastasis of tumor in ovary Two mitoses near center  $\times 265$

what appeared to be a metastasis to the brain, at the end of 5 months. Obviously she was first seen in an advanced stage of the disease. Her life might have been saved had the lesion been recognized and had she presented herself for treatment earlier.

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## DIAPHRAGMATIC HERNIA ASSOCIATED WITH TRAUMATIC GASTRIC EROSION AND ULCER<sup>1</sup>

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SINCE the advent of the roentgen ray a constantly increasing number of cases of diaphragmatic hernia are being recognized. Study of the symptoms of these proved cases has presented a fairly definite clinical syndrome.

Hæmorrhage from the stomach is one of the less common symptoms and is usually associated with severe gastric incarceration. I believe that the bleeding from the stomach is caused by erosion of the mucous membrane at the point of angulation and fixation to the hernial opening or to a structure in the thorax. In chronic cases, this erosion may progress to definite ulceration and may present some of the symptoms of gastric ulcer.

In the last 4 years I have operated in 30 cases of diaphragmatic hernia, in 8 of which there had been hæmorrhage from the stomach. In 7 of these 8 cases, evidence of erosion or ulcer of the gastric mucosa was found at the time of operation. In this paper I shall give complete reports of these 8 cases and a brief resume of the symptoms, operative procedure, and results in the 30 cases in which I have operated.

The ages of these 30 patients were as follows: one patient each 7 months, 3 years, 12 years, 27 years, and 70 years, 6 patients, between 30 and 40 years, 7 between 40 and 50 years, 6 between 50 and 60 years, and 6 between 60 and 70 years. Thirteen were females and 17 were males.

The symptoms of diaphragmatic hernia are often complex, because of the various structures involved. They depend on the amount of mechanical interference with the function of the herniated abdominal viscera, on the degree of interference with the normal motion of the diaphragm, and on the amount of pressure in the thorax which causes impairment of respiration and circulation. The duration of symptoms in this group of 30 cases was from 5 weeks to 24 years; the average duration, 7 years.

This series of cases may be divided into two fairly definite groups. The first group consists of those cases in which the stomach is the only abdominal organ involved in the hernia. There were 20 of these cases: 18 were of the œsophageal type and 2 were of the traumatic type.

The second group of cases consisted of 10 in which several abdominal viscera were incorpo-

rated in the hernia. Eight of these cases were of traumatic origin and the opening was in the left leaf of the diaphragm. The stomach, colon, small bowel, and spleen were present in the hernia in 3 cases; the stomach and colon in 3 cases, the stomach, colon, and small bowel in 1 case, and the stomach, colon, and spleen in 1 case. In only one case of the œsophageal type were multiple abdominal viscera involved in the hernia. This was a case of congenital shortening of the œsophagus in which the colon was pulled into the lower margin of the opening but was in no way fixed in the thorax. There was one congenital hernia resulting from failure of obliteration of the pleuroperitoneal hiatus, in which the entire right and transverse colon and the greater portion of the small bowel were in the left thoracic cavity. This case presented symptoms of intestinal obstruction (Table I).

œsophageal diaphragmatic hernias are usually congenital. The symptoms may begin at birth or at any time during life. There may be a congenital weakness in the œsophageal ring and a definite hernia may later be produced by some type of injury or by increased intra abdominal pressure. These cases may be considered of traumatic origin, but are essentially congenital in the same manner as hernias in the inguinal region. The œsophageal type of hernia produces a more uniform symptomatology than hernias elsewhere in the diaphragm. The symptoms are those of intermittent or progressive incarceration and obstruction of the stomach. At the onset, the attacks are usually mild, they consist of epigastric distress radiating through to the back, come on during or shortly after a heavy meal and are relieved by belching of gas or vomiting. These attacks are not uncommonly considered to be due to disease of the gall bladder. As more of the stomach becomes incorporated into the hernia, the attacks become more severe, the pain radiating straight through to the back and to the lower left side of the thorax, is more marked to the left of the spinal column, and often appears between the shoulder blades. This pain is agonizing and there is difficulty in belching of gas and vomiting because of spasm of the diaphragm and reflex cardiospasm. The spasm of the diaphragm produces an hour glass deformity of the stomach,

<sup>1</sup>Read before the Western Surgical Association, Del Monte, California, December 12-14, 1929.



Fig 1



Fig 2



Fig 3

Fig 1 Roentgenogram of the stomach on admission. Enormously distended stomach with marked torsion, herniation of about half of the stomach into the left part of the thorax through the esophageal hiatus shown by large gas bubble above diaphragm. Apparent obstruction at the pylorus causing retention. Small amount of barium in the lower part of the esophagus.

Fig 2 Roentgenogram of colon made the day after the roentgenogram of the stomach was made. A large residue of barium is shown in abdominal portion of the stomach. The entire colon is in normal position below the diaphragm.

Fig 3 Roentgenogram of stomach on dismissal about a month after operation. The entire stomach is below the diaphragm. The pylorus is not obstructed.

which interferes with the emptying of the upper locus, and causes increased intragastric pressure. The pressure of the herniated portion of the stomach on the lower part of the esophagus interferes with the belching of gas or vomiting. Spasm of the diaphragm is commonly associated with referred phrenic pain in the left shoulder which at times may radiate down the arm. The increased pressure within the thorax causes cardiac embarrassment with palpitation and tachycardia. The pressure on the lung and the interference with the motion of the diaphragm, cause dyspnea. These symptoms are augmented when the patient lies down, and in the more severe cases it is necessary for patients to sit up to breathe. The attacks may last for from a few minutes to several hours, and occasionally are considered to be caused by disease of the arteries of the heart or by myocardial disease. The attacks usually are completely relieved by vomiting and often recur immediately after food is taken. There is often an interval of weeks or months between attacks. It is probable that during the interval between attacks the stomach is not incorporated in the hernial ring and is in its normal position below the diaphragm. When the attacks become more or less constant, it usually indicates that the stomach has become fixed by adhesions in the thorax. All of the early symptoms of pressure are augmented during the attacks. There is loss of weight from inability to

retain food and from marked restriction in diet, due to fear of bringing on an acute attack which may be termed "food fear." The vomiting is more severe and often is of the retention type. During these severe attacks of vomiting, the vomitus may contain blood. If the attacks are of long standing, the patient not uncommonly has a burning sensation in the epigastrium, which comes on after meals and which is relieved by taking small quantities of food. If large amounts of food are taken, it may bring on one of the attacks associated with incarceration of the stomach due to the hernia. Several of these patients have been placed on a diet for ulcer and have obtained partial relief because of the restricted amount of food taken at frequent intervals. Hemorrhage is not a common symptom but usually is indicative of severe incarceration, with fixation of the stomach in the thorax. The bleeding is caused by erosion of the mucous membrane due to the forceful pressure exerted, during the attacks of vomiting, on the large, distorted, congested, and fixed stomach. This erosion may be superficial, or, in cases of long standing, may form a definite ulceration from repeated trauma. This is usually the final stage of incarceration. I have never seen a stomach which was strangulated as a result of hernia nor do I believe that it is possible, because of the powerful musculature and rich blood supply in the gastric wall (Table II).



Fig 4



Fig 5



Fig 6

Fig 4 Roentgenogram of stomach on admission. Congenital oesophageal diaphragmatic hernia with herniation of about a third of the cardiac end of stomach into left side of the thorax through the oesophageal hiatus. Congenital shortening of the oesophagus. Marked scoliosis of the lower dorsal spine. Figures 4 and 5 show condition before and figure 5 after abdominal repair of hernia.

Fig 5 Roentgenogram of chest on admission. Circumscribed pocket with gas bubble partially back of the shadow of the heart in left lower part of the thorax suggests diaphragmatic hernia.

Fig 6 Roentgenogram following abdominal repair of diaphragmatic hernia. The entire stomach is below the diaphragm.

In 3 cases of this series there was associated, severe secondary anaemia. A large gastric ulcer was found on the lesser curvature in one of these cases, and gastric resection was done, but there had been no gross evidence of haemorrhage. The second patient had repeated haemorrhages from the stomach and bowel and at the time of operation gastric erosion was found, which may explain the anaemia. The third case was that of a child in which the chief complaint was gastric distress due to hernia, the concentration of haemoglobin was 20 per cent and there was no haemoptysis or melena. Because of the seriousness of the child's condition, preliminary phrenicotomy was done, which gave almost complete relief of gastric symptoms, and it has now been 3 months since the phrenicotomy and the percentage of haemoglobin has risen to 68. It is difficult to determine the cause of the anaemia in this case. I have seen several cases which presented marked anaemia, with no demonstrable loss of blood, very small hernias, and few symptoms. It is questionable whether this is entirely a separate condition or whether it has direct relationship to the hernia.

In most of the chronic cases which have presented symptoms of vomiting there has been rather marked loss of weight because of inability to retain food and also because of the marked restriction of diet because of the fear of bringing on attacks from heavy or ordinary meals.

The symptoms in traumatic cases in which the stomach alone is involved are practically the same as those in oesophageal cases, but in most of the traumatic cases the colon is involved and there are the added symptoms caused by interference with the function of the colon. This may be indicated by obstinate constipation, with accumulation of large quantities of gas in the colon, or by periodic attacks of partial or complete obstruction. The sudden onset of symptoms in these cases is usually directly related to the injury, the progress of symptoms is much more rapid, and the first symptom may be that of severe gastric haemorrhage or of intestinal obstruction. The respiratory symptoms are usually more marked because of the greater amount of viscera contained in the thorax, these viscera are in direct contact with the lung and pericardium, as there is no hernial sac.

#### TREATMENT

In cases of oesophageal diaphragmatic hernia in which the stomach only is involved and in which the symptoms are mild, the treatment may be conservative. In those cases which present progressively more severe symptoms, the possibility of serious complications is very great, and I believe that all of them should be considered surgical cases unless radical operation is contra-indicated because of the patient's general condition.



Fig 7 left Roentgenogram on admission Left congenital oesophageal diaphragmatic hernia Slight shortening of the oesophagus The entire stomach is above the diaphragm in the left part of the thorax and extends into the right part The heart is displaced to the right

Fig 8 Roentgenogram of stomach 21 days after abdominal repair of diaphragmatic hernia The stomach is in normal position below the diaphragm

tion Surgical treatment should be instituted before severe incarceration with obstruction and traumatic lesions of the stomach have occurred The operative risk is increased by gastric retention and the technical difficulties are enhanced by fixation of the stomach to the diaphragm and structures within the thorax

All cases in which the colon or small bowel are involved in the hernia demand early operation because of the danger of intestinal obstruction These cases are usually traumatic in origin and it is best to delay operation until the acute symptoms have subsided, if the patient's condition will permit

Preliminary paralysis of the diaphragm produced by phrenicotomy is often of value in incarcerated and strangulated hernias because it prevents spasm of the muscle and relaxes the hernial ring It is of great advantage in closing large hernial openings when there is considerable loss of structure of the diaphragm as the relaxation of the muscle permits this defect to be closed without tension and in cases in which the diaphragm has been torn from the wall of the thorax it may be resutured to the intercostal muscles It is also of value in cases in which there is a congenital shortening of the oesophagus because the relaxation, and elevation of the muscle of the diaphragm

following this procedure permits the hernial opening to be sutured around the lower part of the oesophagus entirely above the herniated portion of the stomach It is not necessary in the small type of hernia in which approximation can be accomplished without undue tension In some instances in which it seems advisable to re-establish the function of the diaphragm, the nerve may be cut and sutured and function will be re-established within 3 to 6 months

Phrenicotomy may be used as a palliative measure when the radical operative procedure of closure of the defect in the diaphragm is contra-indicated because of the patient's condition The rationale of this procedure is to prevent spasm of the diaphragm, which is the cause of the severe attacks of incarceration of the stomach I have performed this procedure in 7 cases In 4 cases, radical operation was contra indicated because of the general condition of the patient In the 3 remaining cases phrenicotomy was done preliminary to operative repair, but the operation was unavoidably delayed and the patients have not returned for operation This procedure does not completely relieve the symptoms There is always a moderate amount of gastric distress immediately or shortly after heavy meals but these patients get along fairly well if they are careful with





Fig 9



Fig 10



Fig 11

Fig 9 Roentgenogram of stomach on admission. Diaphragmatic hernia with herniation of two thirds of cardiac end of stomach through the oesophageal hiatus into left thoracic cavity. A gastric ulcer is shown on the lesser curvature at the angulation of the stomach.

Fig 10 Roentgenogram of stomach 1 3/4 months after

operation. The entire stomach is below the diaphragm. A small gastric ulcer is shown high on lesser curvature. Miliary infiltration of barium has occurred in both lungs.

Fig 11 Roentgenogram of stomach 7 months after operation. The entire stomach is below the diaphragm. The gastric ulcer is entirely healed.

their diet. It completely relieves the acute attacks of incarceration if the stomach is not fixed in the thorax. It is not applicable to hernias in which a large portion of the stomach is in the thorax, causing marked pressure on the heart and lungs, nor is it applicable in any case in which the intestines are involved in the hernia.

The only operative procedure which will assure complete relief of symptoms is replacement of the herniated abdominal viscera and repair of the abnormal opening in the diaphragm. I prefer the abdominal approach because I believe that there is little risk of thoracic complications. In cases in which the abdominal viscera are adherent to structures in the thorax, these adhesions can be separated through the hernial ring, with little danger of injury to the abdominal or thoracic viscera, as the definite relationship of the herniated structures can be established. The presence of associated lesions in the herniated abdominal viscera can be determined as well as any other pathological lesion within the abdomen, and there is no deformity following operation.

I have operated in 23 cases by the abdominal approach. In every case, the herniated abdominal viscera were replaced in the abdomen and the opening in the diaphragm was closed by overlapping. In one case a portion of the diaphragm had been entirely torn from the thoracic wall, and was resutured to the intercostal muscle. In one case gastric resection was done for gastric ulcer high on

the lesser curvature at the time of operation. In 2 cases there was a congenital shortening of the oesophagus with marked enlargement of the oesophageal hiatus. This enlarged opening was closed around the lower part of the oesophagus above the herniated portion of the stomach after preliminary relaxation and elevation of the diaphragm by phrenicotomy. In 15 cases, preliminary phrenicotomy was performed, and in 1 case, preliminary phrenicotomy and extrapleural thoracoplasty were done.

Of the 23 patients on whom radical abdominal operative repair of the hernial opening was done, 19 patients recovered from operation, and there have been no recurrences to the present time. I have recently received replies to letters of inquiry, and all patients have been practically relieved of symptoms, except for minor complaints not referable to the hernia.

In the 30 cases in which operation was performed, there were 4 deaths following operation: 1 death, on the twelfth day, from pulmonary embolism, 1, on the seventh day, from pneumonia in the lung of the opposite side, 1, on the second day, from cerebral embolism, and 1, 3 hours after operation from respiratory and cardiac failure due to increased intra abdominal pressure.

I prefer, as an anæsthetic, intratracheal ethylene gas, given with positive pressure, in cases in which there is marked pulmonary collapse. In the last 6 months I have used sodium iso

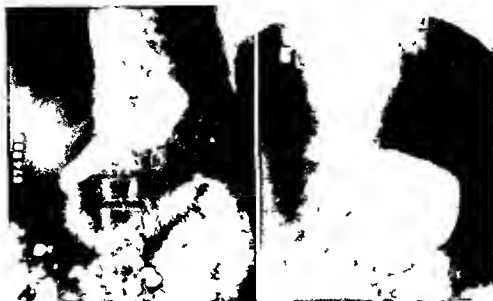


Fig 12 left Diaphragmatic hernia through the oesophageal opening with diverticulum on the lesser curvature just below diaphragm

Fig 13 Roentgenogram 7 months after operation, the resected stomach is in normal position below the diaphragm Anastomosis is free

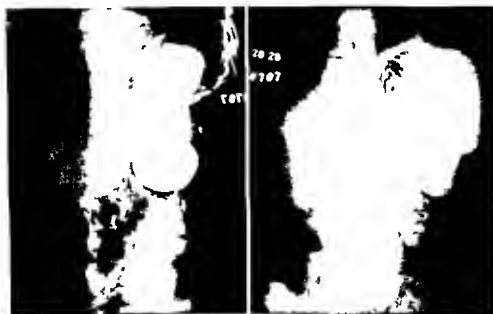


Fig 14 left Roentgenogram of stomach on admission A diaphragmatic hernia is shown with herniation of practically the entire stomach into the left thoracic cavity and extending to the fifth rib posteriorly The opening is close to the oesophageal hiatus

Fig 15 Roentgenogram of stomach 5 weeks after left phrenicotomy and repair of opening in left diaphragm The entire stomach is below the elevated paralyzed diaphragm Evidence of gastric ulcer is not shown

amylethyl barbituric acid intravenously and by mouth preliminary to ethylene gas anaesthesia, with very satisfactory results The blood pressure is taken every 10 minutes during the operation There is usually considerable drop in blood

pressure during dissection of adhesions from the pericardium, and if drop is more than 15 millimeters of mercury, physiological solution of sodium chloride, glucose, or gum acacia, are administered intravenously in the course of the operation



Fig 16 Large diaphragmatic hernia with almost the entire stomach in left thoracic cavity. The pyloric end of stomach is adherent to the anterior margin of opening. A small portion of colon is projecting through the lower margin of the opening. Insert A Large opening in diaphragm is shown just to the left but not involving the esophageal hiatus. Adhesions to the cardiac end of stomach may be noted. Insert B Overlapping closure of large opening in the diaphragm after phrenicotomy.

Postoperative care is of greatest importance in cases in which there has been marked pulmonary collapse over a long period of time. There is usually some delay in expansion of the lung or there may be pneumothorax as the result of the positive pressure on the side of the thorax that was the site of operation. These patients are often greatly benefited by being placed in the oxygen chamber and when there has been serious pulmonary collapse this may be a life saving procedure. Pleural effusion in the side of the thorax on which operation has been done is not uncommon. This fluid

may absorb without aspiration, or it may require repeated aspirations. In one case, an empyema followed atelectasis of the lung on the side on which operation had been done and resection of a rib and drainage were required.

#### REPORT OF CASES

**CASE 1** A woman aged 59 years consulted the clinic August 2, 1926 because of pain in the epigastrium of 9 years duration. She stated that she had been in an automobile accident 9 years before but that she had not been severely hurt. She did not associate her complaint with the injury, but it was about that time that she first had

TABLE I—DATA CONCERNING LOCATION, ETIOLOGY, AND CONTENTS OF HERNIA IN THIRTY CASES\*

Site of opening		Etiology		Contents of hernia	
Classification	Cases	Classification	Cases	Classification	Cases
Esophageal hiatus	17	Congenital Acquired (trauma 3)	5 12	Stomach only	17
Esophageal hiatus	2	Congenital short esophagus	2	Stomach only Stomach and colon	1 1
Hiatus pleuroperitonealis	1	Congenital	1	Colon and small bowel	1
Posterior half and dome of diaphragm	10	Trauma Direct injury Indirect injury	1 8	Stomach only Stomach and colon Stomach, colon and small bowel Stomach, colon and spleen Stomach, colon, spleen and small bowel	2 3 1 1 3
Total	30		30		30

In all cases the hernia was through the left side of the diaphragm. In 5 there was encroachment in the right side of the thorax.

noted intermittent attacks of epigastric pain referred through to the back. There had been no nausea or vomiting and no definite relation of the discomfort to the taking of food. Fatigue and worry had seemed to precede the attacks which would last a few days. Often she would be free from attacks for 2 to 3 months. The gall bladder had been removed 10 years before she came to the clinic with out relief. One year before, attacks had become much more severe. She had had pain behind the ensiform cartilage referred through to the back, to the left of the spinal column, and coming on immediately after eating. Pain had been relieved by vomiting. Three months before she came to the clinic, weakness, lassitude, and loss of weight had appeared and 2 weeks before, she had had a very severe attack of pain with nausea and vomiting of "coffee ground" material. This had occurred several times afterward and for 3 days before examination she had had constant epigastric pain, nausea and vomiting. She had been unable to retain even fluids and the vomitus had contained bright blood. Her bowels had always been constipated and for the last 3 months the stools had been very dark, and her home physician said they had contained blood. She had lost 11 pounds in weight in the 3 months before she came to the clinic.

Examination was essentially negative except for marked tenderness and some rigidity in the epigastrium. Urinalysis gave negative results except for a few pus cells. The concentration of blood urea was 52 milligrams in each 100 cubic centimeters and that of hemoglobin was estimated at 75 per cent. Erythrocytes numbered 4,720,000 and leucocytes 6,400 in each cubic millimeter of blood. Roentgenograms of the thorax revealed an old calcified lesion at the base of the upper lobe of the right lung. Roentgenograms of the stomach gave evidence of a diaphragmatic hernia with about half of the stomach above the diaphragm. A diagnosis was made of esophageal diaphragmatic hernia, with herniation of about half of the stomach through the esophageal hiatus into the left thoracic cavity. The hernia was thought to be probably of congenital origin augmented by trauma. Erosion of the gastric mucosa at the point of angulation was found. The patient was hospitalized and treated for 8 days, conservatively, until the acute symptoms had subsided.

August 10, 1926 I performed an abdominal closure of the enlarged opening. Ether was used as the anesthetic. The abdominal approach was made through an oblique left rectus incision. There were many adhesions around the median portion of the diaphragm. The greater portion of

the stomach had herniated through an enlarged esophageal opening into the thoracic cavity. There was considerable difficulty in replacing the stomach in the abdomen because of adhesions fixing the stomach in the thorax. These adhesions were separated. The stomach was markedly dilated and thick walled as a result of partial obstruction. There was a wide, irregular area of thinning out of the gastric wall on the lesser curvature and on the posterior wall at the point of greatest angulation. The serosa was covered with adhesions which had been separated from the margin of the opening and thoracic portion of the diaphragm. The adhesions were entirely separated from the margins of the opening, and the folds of serous membrane forming an incomplete sac around the cardia, were partially separated and allowed to drop back into the thorax. The opening was about 8 to 9 centimeters in diameter and extended into the left side of the diaphragm. A stomach tube was placed through the mouth, into the stomach, and the opening was closed around the esophagus and was overlapped about 1.25 centimeters. The cardiac end of the stomach was sutured to the diaphragm.

Convalescence was uneventful. There was very little shock following operation. The temperature was 100 degrees F, and the pulse rate 100 on the third day. This was the highest that either pulse or temperature reached. From the sixth day onward temperature and pulse were normal and remained so throughout convalescence. The patient was dismissed from the hospital on the sixteenth day and from observation on the nineteenth day, at which time the wound was practically healed and the general condition was good. A roentgenogram taken the day before dismissal showed the stomach in good position below the diaphragm. The patient's husband is a physician and several letters were received, stating that she was entirely relieved of her previous symptoms by the operation and that she was also relieved of the intermittent Cheyne Stokes

TABLE II ASSOCIATED CONDITIONS

	Cases
Anæmia	3
Gastric hæmorrhage	8
Traumatic gastric erosion	5
Traumatic gastric ulcer	1
Gastric ulcer (traumatic?)	1
Duodenal ulcer	2
Cholecystitis with cholelithiasis	2
Cardiospasm	1

type of breathing while sleeping. In reply to a recent questionnaire her husband informed me that she died suddenly 6 months ago from angina pectoris. She had had no recurrence of any of her previous gastric symptoms.

The hernia in this case was probably of congenital origin, because, preceding the accident, the patient had gastric symptoms which were of sufficient severity to warrant removal of the gall bladder. She was apparently relieved of the symptoms following the cholecystectomy, until the automobile accident which, while the injury was trivial, was sufficient to induce recurrence of the symptoms. Congenital diaphragmatic hernias may begin to give symptoms after some strain or injury, in the same manner as in inguinal congenital types of hernia. This injury may not occur until rather late in life, and the hernia, therefore, may be thought to be of an acquired, traumatic type. The symptoms of diaphragmatic hernia are probably more commonly confused with those of cholecystic disease than with any other lesion of the upper part of the abdomen. I believe that it is always advisable to explore the cardiac end of the stomach and the left leaf of the diaphragm during the course of every operation on the upper part of the abdomen. A complaint of weakness and lassitude is commonly associated with the more advanced types of diaphragmatic hernia in which there is incarceration of a considerable amount of stomach. Vomiting of blood in this case was undoubtedly due to the traumatic erosions of the mucosa of the stomach which occurred during the forceful attacks of vomiting. The operative procedure was without incident. Exposure was adequate, through an abdominal incision, and after separating the adhesions there was no difficulty in replacing the stomach in the abdomen. There was some difficulty, however, in closing the opening in the diaphragm because of the adhesions to the cardiac end of the stomach, which necessitated introduction of the stomach tube to outline the cardiac orifice. Convalescence was unusual because of complete lack of complications in a patient of her age who presented acute symptoms of incarceration before operation.

**CASE 2.** A woman aged 60 years consulted the clinic September 20, 1929, because of colic in the left upper quadrant of the abdomen of 6 weeks duration. The patient said that for the last 35 or 40 years she had had attacks of epigastric distress termed indigestion. The early attacks had not been severe and had consisted of distress in the epigastrium which had seemed to go straight through to the back. These would usually come on after heavy meals or when she was tired. About 25 years before she came to the clinic, she first had had an attack of severe colic in the epigastrium. The pain had radiated to the right shoulder

had been associated with vomiting which did not give relief, and she had required morphine. In the 3 years following she had had several similar attacks associated with jaundice and at the end of that time cholecystostomy had been done for gall stones. After this operation she had had periodic attacks of epigastric distress in which the pain had gone through to the back similar to that in her early attacks. The latter attack, however, had been more severe and usually had been relieved by vomiting or belching of gas. Ten years previously, she had had a severe attack of epigastric distress with shortness of breath and tachycardia, which had lasted for about 2 or 3 days and had been diagnosed as a heart attack. A short time after this she had had an attack similar to gall bladder colic with associated jaundice which had required morphine for relief. She had not had further attacks of this sort. Since then she had had what she termed "heart burn" in the left lower part of the thorax usually noted after heavy meals or exhaustion. Nine months before she came to the clinic, she had had two or three attacks of pain in the left upper quadrant of the abdomen. The pain had radiated straight through to the back. There had been no definite relationship of this pain to the taking of food but the attacks had started in the evening after dinner. She had had more or less constant trouble for 2 or 3 days when she had been relieved by enemas. She had been given a special diet and had been fairly free from symptoms until 6 weeks before she had arrived at the clinic. Since that time she had had five or six attacks of severe pain in the left upper abdominal quadrant which had radiated through to the back and always had come on during or immediately after a meal. Vomiting had completely or partially relieved the pain. She had had no jaundice. Her bowels had always been constipated and at the time she came to the clinic she was taking daily laxatives as she had been doing for 30 years. At the time she presented herself for examination she was unable to take any food or liquids into the stomach without severe distress in the upper left abdominal quadrant and the left side of the thorax and she was afraid to take food because of the fear of bringing on one of the severe attacks. Four years before her visit to the clinic a stone had been removed from the right ureter by manipulation.

The patient complained of difficulty in taking a full breath and being unable to lie on her left side. She weighed 184 pounds, 20 pounds less than she said she had weighed 8 months before. The systolic blood pressure was 186 and the diastolic 104 measured in millimeters of mercury. Concentration of hemoglobin was estimated at 63 per cent. Erythrocytes numbered 3,650,000 and leucocytes 6,700 in each cubic millimeter of blood. Her pulse rate was 96. Examination of the heart gave negative results except for a slight systolic murmur at the mitral valve. There was moderate distention with tenderness to pressure in the upper part of the abdomen. Urinalysis of a catheterized specimen showed an occasional pus cell and albumin graded 2. The concentration of blood urea on admission was 40 milligrams and of blood chlorides 528 milligrams for each 100 cubic centimeters. Carbon dioxide combining power was 87.9 per cent. Analysis of gastric content revealed for each 100 cubic centimeters: total acidity of 52 and free hydrochloric acid of 30 expressed in terms of cubic centimeters of tenth normal sodium hydroxide. Seven hundred and fifty cubic centimeters of gastric content which contained blood were retained. A roentgenogram of the kidneys, ureters and bladder gave negative results and of the gall bladder a normally functioning organ. It was impossible to rule out stones because of the presence of gas. A roentgenogram of the thorax disclosed the shadow of the distended cardiac end of the stomach above the diaphragm and invading the lower third of the

left thoracic cavity. Roentgenograms of the stomach showed an enormously distended viscus, with marked torsion and herniation of about half of the stomach into the left thoracic cavity through the esophageal hiatus. This condition was revealed by a large bubble of gas above the diaphragm. There was apparent obstruction at the pylorus causing retention, and there was a small amount of barium in the lower part of the esophagus.

A diagnosis was made of a congenital, esophageal diaphragmatic hernia, with herniation of practically the entire stomach into the left thoracic cavity. As a result of adhesions, the stomach had become incarcerated in the thorax with almost complete obstruction. There was erosion of the gastric mucosa at the point of angulation.

Because of the obstruction, with retention of gastric content containing blood, a regimen of pre-operative preparation was prescribed, including gastric lavage and intravenous injection of physiological solution of sodium chloride and solution of glucose. The stomach was subjected to lavage after 12 hours and from 600 to 800 cubic centimeters of gastric content was found retained. The gastric content contained blood. After 4 days of pre-operative treatment, the blood urea dropped to 22 milligrams for each 100 cubic centimeters carbon dioxide combining power to 78.7 per cent by volume and blood chlorides to 528 milligrams for each 100 cubic centimeters. October 16, 1929, preliminary phrenotomy was performed on the left side. Anesthesia was effected by ethylene and sodium iso amylethyl barbiturate acid administered by mouth 1 hour before operation. The abdominal approach was made through an oblique left rectus incision. The abdomen was explored and the entire stomach was found to have herniated through an enlarged esophageal opening into the left thoracic cavity. The esophageal opening in the diaphragm was about 8.75 centimeters in diameter, and there was no definite margin posteriorly. The aorta and the esophagus passed through the same opening in the diaphragm. The stomach was adherent to the roargin of the opening. These adhesions were separated, but it was impossible to replace the stomach in the abdomen because of the adhesions which fixed the stomach in the thorax. After the thoracic cavity was exposed by separating adhesions from the outer margin of the opening it was found that there were several large areas of adhesion at the greater curvature of the stomach close to the antrum, which were fixing the stomach to the posterior portion of the thoracic diaphragm. Several of the adhesive bands were very large and were cut between clamps and ligated. There was enormous dilatation of the stomach with marked distortion. The obstruction was undoubtedly caused by fixation of the stomach by the adhesions to the posterior portion of the diaphragm and thoracic wall. There were many adhesions to the pericardium. The adhesions were separated after which the stomach was removed from the thorax. There was a double layer of serous membrane which was continuous with the peritoneum of the anterior wall of the stomach and which passed over the fundus for a distance of about 7.5 centimeters. This was continuous with the thoracic diaphragmatic pleura and was the lower portion of a congenital sac, the upper portion of which either had ruptured or had so markedly thinned out that it was not demonstrable. This was partially excised after the stomach tube had been passed through the mouth into the stomach so as definitely to locate the lower part of the esophagus. The large esophageal opening was then closed around the esophagus, with linen sutures with the stomach tube in place. The first suture incorporated a small portion of the wall of the esophagus in the closure. The remainder of the opening was closed by overlapping the anterior portion over the posterior portion for about 12.5 centimeters and the free

margin was sutured to the posterior thoracic wall in an attempt to obliterate the space between the esophagus and the aorta. Exposure was difficult because of the obesity of the patient, but satisfactory closure was made. There was marked thinning out of the wall of the fundus of the stomach posteriorly close to the adhesions to the posterior margin of the opening. This thinning probably was due to traumatic erosion resulting from the distortion and trauma to the stomach. There was no obstruction at the pylorus and no lesion could be demonstrated in the stomach other than that caused by the trauma. The gall bladder was buried in a mass of adhesions and contained several small stones. Further exploring was not done. The patient was given a transfusion of 500 cubic centimeters of blood by the sodium citrate method.

There was considerable shock following the operation. At the completion of it the patient's pulse rate was 120, the systolic blood pressure was 90 and the diastolic 65. The following day the temperature was 101 degrees F and the pulse rate 120. Respirations were 26 to 30 a minute. The respiratory rate dropped to approximately normal by the sixth postoperative day and remained normal during the remainder of convalescence. The only symptom of which the patient complained was shortness of breath. Roentgenograms of her thorax 4 days after operation revealed some fluid at the base of the left thoracic cavity. This remained present for about 3 weeks, was gradually absorbed, and did not require aspiration. The only other complication in convalescence was reactivation of sciatica which had troubled the patient for years and which kept her confined to the hospital for a week or 10 days after the wound was entirely healed. At the time of her dismissal she was free from gastric or respiratory symptoms. She was dismissed from the hospital on the twenty ninth day and from observation on the thirty sixth day after operation. She still complained of some sciatica in the left thigh (Figs. 1, 2 and 3).

This patient presented a confusing clinical history of diaphragmatic hernia complicated by definite disease of the gall bladder. It is probable that her early attacks were those of diaphragmatic hernia and that later they were complicated by cholecystitis with cholelithiasis. It is possible that the increased intra-abdominal tension caused by the distention and vomiting associated with the attacks of disease of the gall bladder were factors in increasing the amount of herniated stomach. The severe attacks simulating cardiac disease were probably the result of increased pressure in the thoracic cavity. The heart was found to be normal at the time of examination. The stomach undoubtedly had been incarcerated in the thorax for 6 weeks prior to her examination, and it is probable that the finding of blood in the gastric content was the result of a recent traumatic erosion resulting from severe attacks of vomiting because of the marked pyloric obstruction. The roentgenological examination is interesting in view of the fact that it could not be definitely determined whether or not there was an intrinsic obstruction at the pylorus. This is the only case which I have seen of esophageal hernia in which the aorta and the esophagus passed

through the same opening in the diaphragm. The preliminary paralysis of the diaphragm by phrenicotomy was of great aid in closing the enlarged opening both because of its unusual position and size and the obesity of the patient. The gastric erosion was evidenced by the thinning of the gastric wall. A definite lesion was not demonstrable on the serous coat of the stomach except where the stomach had been separated from the margins of the opening.

**CASE 3.** A woman aged 54 years came to the clinic November 19, 1928 complaining of epigastric distress and pain in the left side of the thorax immediately after eating of 4 years duration. Marked lymphosis had been present since she had suffered a severe fall in her fifth year of life. She had never been treated for this. There was no history of tuberculosis. Since childhood she had had some indigestion which she termed heart burn after taking heavy foods such as sauer kraut or corn bread. This distress had been periodic and never of much trouble to her. The stomach trouble had been less severe since she had come to this country at the age of 26 years. This she attributed to the better quality of food in this country. She had always worked hard, had done all of her housework, washing and so forth. For 10 to 15 years before she came to the clinic she had noted heart burn after taking coffee and some types of food, but particularly following coffee. This had been relieved immediately by belching of gas. The gastrointestinal tract had always been regular in its action. Four years before she presented herself for examination she had begun to have, after extreme exertion, marked epigastric distress immediately after eating, with pain in the left lower part of the thorax and occasional attacks of vomiting which would give relief. She had begun to restrict her food because of the distress in her stomach and had noticed that she had little trouble when she had eaten small quantities. She had consulted her physician who had thought that her trouble was due to anemia and she was treated for this. She was given six blood transfusions but only slight improvement in the anemia had resulted. Blood had been noted in the stool and she had been thought to have an ulcer of the stomach. The gastric distress had become progressively more marked and she feared to take food because of the distress which followed soon after the food entered the stomach. This distress had become more or less constant, had become situated in the epigastrium extending into the lower left part of the thorax and the only time that she was entirely relieved of it was in the morning. If she took a large quantity of food she might vomit or belch gas and gain partial relief, but she continued to have a moderate amount of distress. She was unable to sit down with comfort and kept on the go most of the time. She had more distress with moderate dyspnea when she lay down and she usually slept with three pillows. She had had many severe attacks of vomiting had lost 15 pounds in weight and marked weakness had developed as a result of inability to take food. For the last month she said she had been unable to take solid foods had confined her diet to various types of soups and even then at times might have marked epigastric distress which occurred immediately after the fluid had entered the stomach. The attacks had been accompanied by the sensation of pressure in the left lower part of the thorax and in the back.

General examination gave negative results except for revealing evidence of emaciation and loss of weight. Bronchial breathing was heard at the bases of both lungs and râles were more marked at the left base. The systolic blood

pressure was 124 and the diastolic 74. Urinalysis gave negative results. Examination of the blood disclosed a concentration of hemoglobin of 46 per cent and 3,700,000 erythrocytes and 4,800 leucocytes in each cubic millimeter. There was moreover, moderate anisocytosis and poikilocytosis, the proportion of reticulated cells was 0.6 per cent and platelets numbered 228,000 for each cubic millimeter. The Wassermann reaction on the blood was negative. Roentgenograms of the thorax gave evidence of a gas bubble over the cardiophrenic angle which suggested a diaphragmatic hernia. A roentgenogram of the stomach showed the signs of congenital esophageal diaphragmatic hernia with herniation through the esophageal hiatus of a third of the cardiac end of the stomach into the left side of the thorax. Congenital shortening of the esophagus also was seen and there was marked scoliosis of the lower part of the thoracic portion of the spinal column. There was erosion of the gastric mucosa at the point of angulation.

November 28, 1928 preliminary left phrenic evulsion was performed. December 1 the hernia was repaired. Intratracheal ethylene anesthesia was used. The abdomen was explored through an oblique left rectus incision. On exposing the upper part of the abdomen it was found that approximately half of the cardiac end of the stomach had passed into the left thoracic cavity through a large esophageal opening, which was about 9 centimeters in diameter. The greater portion of the stomach was easily replaced in the abdomen, but immediately below the esophagus a sac of peritoneum extended over the entire cardia for a distance of 12.5 centimeters toward the fundus. This leaf of peritoneum was separated from the stomach and was dropped back into the abdominal cavity; it formed definitely the sac of the hernia. It probably resulted from failure of obliteration of the infracardiac bursa for the stomach had probably been in the thorax at the time of the closure of the esophageal opening and had later only partially descended resulting in slight shortening of the esophagus. The opening was triangular and the apex of the triangle was toward the center of the left half of the diaphragm. The stomach tube was placed into the stomach through the mouth to clear the outline of the cardiac orifice of the stomach and the enlarged esophageal opening was closed with this tube in place. Because of the triangular shape of the opening and slight shortening of the esophagus three plications were made of the diaphragm about the opening, one posterior, one to the right and one extending into the left leaf of the diaphragm. Closure was made by overlapping for about 1.25 centimeters with linen sutures. A satisfactory closure was made. A lesion could not be demonstrated in the serosa of the stomach, but there was some thinning out of the gastric wall along the lesser curvature at the point of angulation around the hernial opening. This probably had caused moderate erosion of the mucosa as well as bleeding from the stomach. Exploration of the gall bladder showed it to be normal to observation and palpation.

There were many adhesions between the fundus of the stomach and pericardium and there was considerable fall in blood pressure as these adhesions were separated; otherwise operation was without incident. The blood pressure rose again shortly after the adhesions had been separated and at the completion of the operation the systolic pressure was 120 and the pulse rate 140. On the second day after operation the temperature was 100.5 degrees F and the pulse rate 130. On the fifth day the pulse had dropped to 90 and the temperature to normal and had remained so throughout convalescence. The patient was dismissed from observation 22 days after the operation at which time her wound was entirely healed and her general condition was good. She was taking practically all kinds of food

without any distress, and a roentgenogram of the stomach, taken the day before dismissal, showed the stomach to be entirely below the diaphragm. Four months after the operation I received a report of a blood test taken at home, showing the concentration of hemoglobin to be 95 per cent and the number of erythrocytes 5,400,000 for each cubic millimeter. This indicated that the anemia had been due to loss of blood as the result of the gastric erosion. She had not had other treatment for the anemia. In reply to a questionnaire about 1 year after operation she stated that she is completely relieved of symptoms and that her general condition is good. She has some shortness of breath on exertion which she attributes to the condition of her heart (Figs 4, 5 and 6).

The kyphosis in this case was very marked and was associated with marked deformity of the entire thorax. It was impossible to determine the cause of this but she attributed it to an injury which she had sustained in childhood. This injury may have been a factor in producing the diaphragmatic hernia, although the short oesophagus and the presence of a definite sac would indicate a congenital type of hernia. The diaphragmatic hernia had apparently been present since birth and had caused few symptoms until 4 years before she came to the clinic when she had undergone extreme exertion. This would indicate that trauma had been a factor in increasing the proportion of the stomach which had passed through the opening. Anemia is not uncommonly associated with diaphragmatic hernia, and in this patient it was thought that the anemia was due to gastric ulcer, because of the blood in the stool, although there were no clinical symptoms suggestive of ulcer. The fact that the anemia rapidly improved after the hernia had been repaired is suggestive that the anemia was associated with the gastric erosion and subsequent hemorrhage, although I have seen several cases of diaphragmatic hernia associated with anemia in which there has been no evidence of loss of blood. The congenitally short oesophagus was the result of a developmental defect, the stomach had not completely descended from the thorax at the time of the formation of the diaphragm. The preliminary paralysis of the diaphragm produced by phrenicotomy was a great aid in effecting closure of the enlarged oesophageal opening and the relaxation and elevation permitted the diaphragm to be sutured around the lower part of the oesophagus, above the cardiac end of the stomach.

**CASE 4.** A boy, aged 12 years, was brought to the clinic November 13, 1928, complaining of vomiting of 9 years' duration. The child was the first of five children, had been born at full term, weighing 6 1/2 pounds, and delivery had been difficult. At birth he had been tongue tied and had not been able to nurse from the breast, but after the frenum of the tongue had been cut, he had nursed without difficulty. He had developed normally until he had had pneu-

monia at the age of 13 months. He had recovered after 2 weeks' illness and had done well until about the age of 3 years. At that time he had had an attack of vomiting which had lasted about 2 weeks. He had vomited daily, and the vomitus had consisted of rather thin, brownish material which the attending physician had identified as blood. He had had tarry stools and had had a slightly increased temperature at the time. He had complained of pain in the epigastrium although the quantity of food taken had been very small. Following this illness, he had had about one attack of vomiting each month, most frequently at night, when he would awaken with discomfort in the epigastrium and left side of the thorax which would be entirely relieved by vomiting. This had continued until about 1 year before he was brought to the clinic when he had begun to have emesis two to three times daily and also hæmatemesis. These spells of vomiting would come on at any time, usually after meals, but at times during meals. The vomitus always had contained material like coffee grounds, but never any bright red blood. Just before vomiting there was usually slight distress in the right epigastric region which would last about 15 minutes. The vomitus would often stick in the patient's throat and he would induce vomiting by forcing his finger into his throat. He had lost rapidly in weight and strength. He had been taking a diet for ulcer for several years, with partial relief. He had not been able to play around with other children but had become tired easily and had had to stop activities and remain quiet. At the age of 4 years he had had several attacks of pain in the right lower portion of the abdomen which had been diagnosed as appendicitis, and the appendix had been removed when the patient was 5 years old. He had had no recurrence of similar attacks since the operation. About 1 year before he was brought for examination he had had pneumonia, characterized by fever and pain in left side of the thorax and by vomiting of bloody material. He had had no cough or expectoration. This condition had lasted for a period of 5 days.

Examination revealed that the patient weighed 16 pounds less than his customary weight. His weight at the time of examination was 43 pounds. The heart sounds were audible in the right side of the thorax. Breath sounds in the left lung were bronchial in type, with many indefinite gurgling sounds. Urinalysis gave negative results. The concentration of hemoglobin was 70 per cent, erythrocytes numbered 4,500,000 and leucocytes 7,400 in each cubic millimeter of blood. Roentgenograms revealed elevation of the diaphragm on the left side and displacement of the heart to the right. There was a gas bubble and fluid above the level of the diaphragm.

A diagnosis was made of congenital oesophageal diaphragmatic hernia, with herniation through the oesophageal hiatus, of the entire stomach and a small portion of the transverse colon into the left side of the thorax with encroachment into the right side of the thorax. Congenital shortening of the oesophagus and erosion of the gastric mucosa at the point of angulation were believed to be present.

November 17, 1928, preliminary left phrenicotomy was performed under local anesthesia and 4 days later the hernia was repaired. Intratracheal ethylene anesthesia was employed. An oblique left rectus incision was made. When the abdomen was explored it was found that the entire stomach and a small portion of the transverse colon were absent. They had passed through an enlarged oesophageal opening into the left side of the thorax, swinging around the pericardium and encroaching on the right half of the thorax, consequently pushing the mediastinal pleura to the right. The herniated transverse colon and stomach were easily replaced in the abdomen, since there were only a few



adhesions between the stomach and the thoracic portion of the herniated sac. These were most marked at the cardiac orifice and it was found that there was a definite hernial sac extending through the oesophageal opening over the upper portion of the stomach. There was slight shortening of the oesophagus probably it was about 3.75 centimeters shorter than normal. The opening in the diaphragm was very large it was about 7.5 centimeters in diameter. The congenital adhesions and fascia of the sac which was probably a persistent infracardiac bursa were separated from the fundus of the stomach and allowed to drop back into the thorax. A stomach tube was placed through the mouth into the cardiac orifice of the stomach to isolate the structure so that the opening in the diaphragm would not be closed too tightly. The oesophageal opening in the diaphragm was then closed around the oesophagus. One silk suture was taken through the median or right border of the opening, it was passed through the anterior and posterior margins and it incorporated in the closure the small portion of the wall of the oesophagus just above the lesser curvature. A similar suture was taken on the left side of the oesophagus and incorporated a small portion of the oesophagus on the side of the greater curvature, leaving a normal sized opening in the oesophagus between these two sutures. The remainder of the opening extended into the left leaf of the diaphragm and was closed by overlapping from above the anterior over the posterior portion for about 1.8 centimeters. The diaphragmatic muscle around the opening was under considerable tension but a satisfactory closure was obtained by overlapping with silk sutures. The fundus of the stomach was then sutured to the diaphragm as far as the margin of the closure. There were many congenital adhesions throughout the abdomen. The colon was adherent to the abdominal wall and the duodenum which was much higher than normal was immediately under the left lobe of the liver. These features were undoubtedly the result of the position of the stomach and were not disturbed. The stomach was markedly dilated and thick walled and there was some irregularity along the lesser curvature where it was angulated around the pericardium into the right half of the thorax. This irregularity was probably the result of traumatic erosion due to distortion but no definite ulcer involving the serosa of the stomach could be demonstrated.

There was considerable shock following the operation but the patient stood it as well as could be expected. His pulse rate was 150 at the completion of the operation. On the following day the pulse rate was 120 and the temperature 101 degrees F. On the third day the pulse rate dropped to 100 and the temperature to 99.2 degrees F. On the fourth day the temperature dropped to normal and the pulse varied from 80 to 90 and continued thus throughout convalescence. The patient was dismissed from the hospital on the sixteenth postoperative day and from observation on the twenty first day in good general condition with the wound entirely healed. He was taking solid food and was not having gastric discomfort. In a recent reply to a questionnaire 1 year after operation it was stated that his general health was good and that he was completely relieved of symptoms. His weight was 61.5 pounds which is a gain of 18 pounds. He is going to school every day and is joining in the activities of other boys. He is able to eat all types of food without any gastric discomfort (Figs 7 and 8).

The clinical history in this case is of interest in that the hernia had undoubtedly been present from birth and that there had been no symptoms until the patient was 3 years of age. After he had

begun to have trouble, the symptoms had been progressive and severe. Because of the severe vomiting, with blood in the gastric content, a diagnosis of ulcer had been made and he had been given medical treatment for ulcer for several years, with very little improvement in his symptoms. The loss of weight had been marked for a boy of his age, he had lost 16 pounds in 1 year. This undoubtedly had been due to his inability to retain food. Because of the number of hemorrhages he had had from his stomach, slight secondary anemia had developed. The roentgen ray was of great advantage in this case in determining the type of hernia and the congenital shortening of the oesophagus. Because of the short oesophagus, it was thought best to do preliminary phrenicotomy in order to elevate the diaphragm so that it could be sutured above the fundus of the stomach. This is the only case of oesophageal diaphragmatic hernia in which I have operated and in which a portion of the colon has been incorporated in the hernia. The function of the colon was not interfered with in any way, in this case, a portion of the transverse colon had been drawn into the lower part of the opening by its attachment to the lower part of the stomach, and inasmuch as the entire stomach was in the thorax it had dragged a small loop of colon up behind it and probably the colon was not incorporated in the hernia the greater part of the time. The short oesophagus was definitely a congenital malformation. It is probable that the cardiac end of the stomach was in the thoracic cavity at the time of the embryonic fusion of the septum transversum with the dorsal mesentery and the pleuroperitoneal membrane which formed the diaphragm. This may be termed a thoracic stomach, but I do not believe that the term should be applied in a case of this kind. It may have been a thoracic stomach at the time of the formation of the diaphragm and, by partial descent, almost reached its normal position. The hernial sac may be considered a persistent infracardiac bursa. The hemorrhages present over such a long period of time undoubtedly were due to the repeated erosions of the mucous membrane of the fixed, distorted, and dilated stomach caused by the forceful vomiting. The child has not had further symptoms or hemorrhages since repair of the hernia.

**CASE 5** A woman aged 49 years consulted the clinic December 10, 1927, complaining of epigastric pain and vomiting which she had had since early childhood. As a small child the patient had had a great deal of trouble with the stomach and attacks of vomiting following eating. She had been placed in bed and given liquid food until the pain

had subsided. These attacks had occurred at irregular intervals more often in the 12 years prior to her visit to the clinic, and usually had been noted after she had eaten heavy foods, also, they usually had been associated with marked abdominal distention. Relief had been obtained by enemas and laxatives. When these attacks occurred, she said, she ate very light food, for she felt better when the stomach was empty. For the 3 or 4 years before she presented herself for examination she had noted, occasionally, a burning sensation which had been relieved by small amounts of food. She complained of marked pyrosis after eating carbohydrates and meats. In the last 1½ years she had had eight attacks of severe epigastric pain, which had doubled her up and which had lasted from 2 to 3 hours. The attacks had been relieved by vomiting and the vomitus, on several occasions had contained blood. She often would eat an ordinary meal and immediately afterward would have this epigastric distress and would induce vomiting, with complete relief. For 6 months she said, she had had practically constant epigastric distress and she felt better when the stomach was empty, although at times she was partially relieved by taking a small amount of food. She was unable to take milk because it formed gas in her stomach which gave her a great deal of discomfort. She did not have night pain which simulated ulcer but she had marked distention of the abdomen which always was better toward morning. She often vomited food taken 12 to 14 hours previously. She had had obstinate constipation for the 2 months before examination. At the time of her arrival at the clinic she had an acute attack of severe epigastric pain with marked abdominal distention. She vomited 850 cubic centimeters of material containing undigested food and blood. The acute distress was relieved by gastric lavage, enemas, and atropine followed by sedatives. After 2 days the acute symptoms had subsided and the examination of her stomach by roentgen ray showed eventration of the left half of the diaphragm and gastric ulcer with hour glass stomach.

General examination gave essentially negative results. No evidence of loss of weight was elicited. The systolic blood pressure was 130 and the diastolic 70. Analysis of gastric content disclosed total acidity of 64 and free hydrochloric acid of 38. The total quantity of gastric content recovered was 400 cubic centimeters. The concentration of hemoglobin was 75 per cent, erythrocytes numbered 4,800,000 and leucocytes 7,900 for each cubic millimeter of blood. Urinalysis gave essentially negative results. The concentration of the blood urea was 44, and of blood chlorides, 479 milligrams for each 100 cubic centimeters, the carbon dioxide combining power was 68 per cent by volume. A second roentgenogram of the stomach revealed an oesophageal diaphragmatic hernia with gastric ulcer. A diagnosis was made of a congenital oesophageal diaphragmatic hernia with herniation into the left thoracic cavity of two thirds of the stomach, through the oesophageal hiatus, adhesions causing incarceration, and an associated traumatic gastric ulcer. The condition was thought probably to be congenital.

December 13, 1927, closure of the enlarged oesophageal opening was made. The abdominal approach was made through a median line incision. There were many adhesions throughout the upper part of the abdomen, and only a small portion of the pyloric end of the stomach remained in the abdominal cavity. Approximately two thirds of the cardiac end of the stomach had herniated through an enlarged oesophageal opening into the left half of the thorax. The stomach was dilated to fully three times normal size and was held firmly in the thorax by adhesions and by the negative pressure in the thorax. A stomach tube was placed in the stomach to relieve the intragastric

pressure and to remove the gastric secretions which could not be aspirated before operation. After the adhesions had been separated from the pericardium and diaphragm, the stomach was replaced in the abdomen. The oesophageal opening was about 7 centimeters in diameter and extended into the left leaf of the diaphragm. There was a definite hernial sac of the congenital type adherent at the fundus of the stomach and extending into the thorax. The upper portion of the sac apparently had ruptured and this had permitted the stomach to extend inside of the left pleural cavity. There were a few adhesions to the lower lobe of the lung. A portion of the sac around the cardia was excised and allowed to drop back into the left pleural cavity. There were a few adhesions to the lower lobe of the lung. A portion of the sac around the cardia was excised and allowed to drop back into the thorax, and the enlarged oesophageal opening was closed around the oesophagus with the stomach tube in place, the innermost suture incorporated the lower part of the oesophagus in the closure. The remainder of the opening was closed by overlapping a double row of linen sutures being used. On exploration of the stomach it was found that it was markedly dilated and that the walls were thick, congested and oedematous as a result of the recent incarceration. About the center of the lesser curvature, at the point of greatest angulation of the stomach when in the thorax, there was marked congestion of the vessels in the serous covering, over an area of about 2.5 centimeters, and there was some thinning of the gastric wall. Induration or a definite crater could not be felt. There were many adhesions around this entire area where it had been adherent in the thorax and I believe that the area was one of traumatic erosion of the mucous membrane as a result of the marked angulation and incarceration of the stomach in the thorax. This will probably heal after reduction of the hernia. I advised that the patient be kept under observation.

There was marked reaction following the operation. The patient was given a transfusion of 500 cubic centimeters of citrated blood. There was marked cyanosis and she was placed immediately in an oxygen tent. Her pulse rate was 130, temperature 100 degrees F and respirations 36 to 48 each minute. On the fourth day after operation the pulse rate dropped to 80 and the temperature to 99 degrees F. Respirations were 24 each minute. The oxygen tent was removed, the temperature rose to 102.5 degrees F, the pulse rate to 110, and respirations to 32. She was again immediately placed in an oxygen tent and remained there until the seventh day when the temperature pulse and respiratory rate dropped to practically normal. The oxygen was used intermittently to the tenth day after operation, when it was discontinued entirely. She was dismissed from the hospital on the twenty eighth day. She was kept under observation for 1½ months after operation and at the time the roentgenologic examination was made, January 31, 1928, the stomach was found to be in normal position and there was a small niche on the lesser curvature, much smaller than it was at operation. She returned for examination 7 months after operation at which time a lesion could not be demonstrated in the stomach. The organ was in normal position and she had been completely relieved of her attacks of gastric distress but continued to have some mild distress following the eating of fried and greasy foods. Analysis of gastric content at this time revealed total acidity of 40 and free hydrochloric acid of 26. The total quantity of gastric content recovered was 100 cubic centimeters. The patient returned again, on request 1 year after the operation, at which time the analysis of gastric content revealed total acidity of 52 and free hydrochloric acid of 38 in a total quantity of 110 cubic centimeters. Roentgenograms of the stomach gave negative

results concerning intrinsic structure and showed it to be in normal position. In reply to a recent questionnaire the patient stated that she had not had a recurrence of gastric symptoms suggestive of diaphragmatic hernia or ulcer (Figs 9 and 10 and 11).

This case is of great interest because of the area of ulceration noted on the lesser curvature of the stomach. It was definitely visualized by roentgen ray before operation and could be definitely demonstrated in the serous coat at the time of operation. The unusual appearance of the ulcer suggested its traumatic origin. There was not the usual inflammatory reaction which surrounds the ordinary type of gastric ulcer but there was definite thinning out of the gastric wall and a sensation as of a shallow crater was imparted to the palpating hand. I believe that this ulcer had been present for a long time, for the patient had noted a burning sensation, that occasionally had been relieved by taking small quantities of food, for the last 3 or 4 years. This, and the occasional hemorrhages, are the only symptoms which suggested ulcer. The rest of her complaint was characteristic of diaphragmatic hernia. Further observation and roentgenologic study of the stomach indicated definitely that the ulcer healed after the stomach had been replaced in its normal position below the diaphragm. This healing was complete at the end of 7 months. I believe that one is justified in assuming that the forceful motion of the stomach associated with attacks of vomiting had resulted in repeated gastric erosions which finally had produced definite traumatic ulceration.

**CASE 6.** A woman aged 59 years consulted the clinic October 14, 1926 complaining of attacks of epigastric pain associated with dyspnea of 12 years duration. She had had indefinite abdominal distress associated with gastric distress since childhood. Twelve years before admission she had had an acute attack of appendicitis and the appendix had been removed. Not long after this operation pain had developed in her throat behind the lower part of the sternum and attacks of weakness, shortness of breath and exhaustion had appeared. These attacks had been mild and infrequent at first. Eight years before she came to the clinic attacks had become more severe and she had noted epigastric pain going through to the back at times radiating up to the neck, and occasionally she had had pain in the suprasternal notch which she had noted first after appendectomy. These attacks had lasted about a half hour and had come months apart, often they had come on following exertion and had been relieved by atropine. In the last 3 years she had had more constant trouble. Three years before she presented herself for examination gastric ulcer had been diagnosed by roentgen ray and she had been given the Sippy diet for 2½ years with some good effect. Six months ago she said she had had a severe attack lasting 10 days with waves of pain in the epigastrium and lower part of the thorax going through to the back. There was a sense of oppression noted in breathing and a strangled feeling. Several times in a night she would have to

sit up to breathe when the distress came on. She had more or less constant soreness in the upper part of the abdomen. Ingestion of food would not seem to be a factor. An attack could be brought on at any time by exertion or nervousness. Her appetite had been good. Definite distress had appeared 2 to 3 hours after meals. Her bowels were constipated and she would take a drastic saline cathartic every morning during an attack. Melena had not been noted.

Examination revealed loss of weight of 12 pounds in the last 6 months otherwise nothing distinct was found. The systolic blood pressure was 160 and the diastolic 84. The pulse rate was 90. Concentration of hemoglobin was estimated as 58 per cent, erythrocytes numbered 3,700,000 and leucocytes 8,200 in each cubic millimeter of blood. The color index was 0.7+. Roentgenograms of the thorax revealed a bubble of gas in the stomach behind the shadow of the heart. Roentgenograms of the stomach revealed evidence of diaphragmatic hernia with herniation of the cardiac end of the stomach through the esophageal opening and a small diverticulum on the lesser curvature just below the diaphragm. A diagnosis was made of esophageal diaphragmatic hernia with herniation through an enlarged esophageal opening of a third of the cardiac end of the stomach into the left thoracic cavity with an associated gastric ulcer high on the lesser curvature of the stomach.

October 21, 1926 I closed the enlarged esophageal opening. Ether anesthesia was used. The abdominal approach was made through a high oblique left rectus incision. There were many adhesions from a previous operation throughout the upper portion of the abdomen. The stomach was dilated and thick walled and about a third of the cardiac end had herniated through an enlarged esophageal opening into the thoracic cavity. There was a serous membrane around the cardia forming a sac which was partially excised and the stomach was replaced in the abdomen. There were many adhesions at the lesser curvature around a large gastric ulcer high on the stomach about 7.5 centimeters from the cardia. After these adhesions had been separated the opening in the diaphragm was entirely exposed and was about 8.75 centimeters in diameter. The enlarged opening was closed around the esophagus after a tube had been placed in the stomach through the esophagus to outline the cardia. The opening in the left side of the diaphragm was closed by overlapping about 2 centimeters with interrupted sutures. The ulcer was very high on the lesser curvature and it was necessary to do almost complete gastrectomy. About a fifth of the cardiac end of the stomach was preserved to which the jejunum was anastomosed after the Bilya type of operation. Anas-tomosis had to be made without using clamps. Microscopic examination of tissue from the stomach revealed a chronic perforating gastric ulcer between 2 and 3 centimeters in diameter. The regional lymph nodes were the seat of inflammation. There was considerable shock following the operation and the patient was given a transfusion of 500 cubic centimeters of citrated blood immediately after the operation.

Convalescence was uneventful except for a small amount of fluid at the base of the left pleural cavity which did not require aspiration and bronchopneumonia in the base of the left lung. The patient was dismissed from the hospital on the twenty-second postoperative day and from observation on the thirty-fifth day. The wound was entirely healed and her general condition was good. A roentgenogram of the stomach at the time of the patient's dismissal showed it to be in good position below the diaphragm. She has returned several times for examination and at the last visit May 28, 1928 a roentgenogram of the stomach showed the anastomotic opening to be free and the stomach in normal

position below the diaphragm. Her general condition was good. Former symptoms had not recurred. She had had some diarrhoea and occasional regurgitation of bile which probably was due to the long loop of jejunum made necessary by the high gastric resection. In a recent reply to a questionnaire, she stated that her general condition was good and that she was completely relieved of symptoms (Figs. 12 and 13).

The early history in this case suggested a lesion in the lower part of the oesophagus or in the cardia. The later history is that of a patient with diaphragmatic hernia, with reflex pyloric pain radiating into the back and shoulder. There was very little in the symptoms to suggest ulcer and little benefit was derived from the Sippy treatment. It is probable that the partial relief which she reported was obtained from moderate quantities of food taken at frequent intervals. At the time of operation, the situation of the ulcer, at the point of angulation of the stomach through the oesophageal ring, suggested its traumatic origin. This ulcer, however, was surrounded by a definite inflammatory area which was fairly typical of the usual gastric ulcer, except that the area was not as large as would be expected in the ordinary gastric ulcer with a crater of this size. The only adhesions which were present were those attached to the diaphragm. Because of its unusual size, it presented the roentgenological appearance of diverticulum of the stomach. The pathological examination of this ulcer showed it to be of a simple inflammatory type. It is probable, as suggested, that it was primarily a traumatic ulcer and that the constant dragging of the herniated portion of the stomach had resulted in the huge crater which simulated a diverticulum. This opinion is further substantiated by the absence of any clinical history of ulcer.

**CASE 7.** A man, aged 27 years, consulted the clinic January 7, 1926 because of vomiting and epigastric pain of 1½ years duration. Five and a half years previously, he had been shot accidentally through the upper left portion of the abdomen with a 22 caliber rifle. The bullet had lodged in the lumbar muscles of his back. An immediate operation had been performed and the puncture wounds in the stomach had been sutured. He had had no further trouble for 6 months when attacks of epigastric pain, weakness and vomiting had developed. The symptoms had been thought to be due to disease of the gall bladder or to gastric ulcer, and operation had been advised. He had been operated on 5 years before he came to the clinic at which time he was found to have a tumor wrapped around the large bowel which was removed. Following this operation he regained his health and weighed 200 pounds. For the following 3 years he was practically well except for periodic attacks of epigastric distress after meals. One and a half years ago he said he had noted this distress more constantly and he had begun to vomit his food ½ to 1 hour after meals. Vomiting had been very forceful, had come

on suddenly, and usually after taking heavy foods, such as meat, fried foods and so forth. The vomiting had consisted of food recently taken. For the last 6 months he had been troubled with obstinate constipation, requiring daily laxatives. The epigastric pain had become progressively worse with acute exacerbations of sharp pain in the left lower part of the thorax, and marked dyspnoea coming on 15 minutes to 1 hour after meals. The pain often was severe, he would double himself up, and was caused only by solid food. Liquids caused little, if any, trouble. The pain always was immediately relieved by vomiting, but the dyspnoea was often not relieved although he could usually go on with his work. In the last 3 months he had vomited daily two to three times, practically after every meal, and at times the vomitus had contained material like coffee grounds. He had lost 45 pounds in weight. On the day of his arrival at the clinic, he had an acute attack and was placed in the hospital. He vomited 1,000 cubic centimeters of material like coffee grounds, containing blood and partly digested food. Five hundred cubic centimeters more was obtained by gastric lavage but the pain was not entirely relieved until morphine had been administered. Pre-operative preparation was prescribed consisting of daily gastric lavage, low residue diet, physiologic solution of sodium chloride given intravenously and enemas. This treatment was continued until the acute symptoms had subsided and the general condition had improved.

General examination was essentially negative except for evidence of loss of weight. The blood pressures were 115/85 systolic and 65 diastolic. The concentration of haemoglobin was 81 per cent, erythrocytes numbered 4,460,000, leukocytes 6,000 in each cubic millimeter of blood. There were no breath sounds were heard over the left lung. There was abnormal splash and gurgling sounds were heard over the heart sounds were best heard behind the sternum on the right side of the thorax. Roentgenograms of the chest each showed herniation of almost the entire stomach into the left thoracic cavity. A diagnosis was made of traumatic diaphragmatic hernia, with herniation of the entire stomach and transverse colon, together with the great omentum, into the left thoracic cavity. A large opening in the left side of the dome of the diaphragm.

January 28, 1926, left phrenicotomy and a pair of the large traumatic opening in the diaphragm were performed. Ether was used as an anesthetic. The abdominal approach was through a midline oblique, left rectus incision. There was a large number of adhesions throughout the entire upper abdomen, most marked around the liver and stomach. The phrenic. Practically the entire stomach and the greater portion of the transverse colon and the greater omentum were herniated through a large opening in the median portion of the left part of the diaphragm. The omentum was adherent to the greater curvature of the stomach and two thirds of the opening had herniated into the thorax, and was very adherent to the transverse colon, diaphragm and lateral thoracic wall. The stomach and to the lower lobe of the lung. The lung was so firm that small pieces had to be ligated and left attached to the stomach. These adhesions were separated and the stomach and colon were replaced in the abdomen. The stomach was enormously dilated as a result of having contained considerable fluid and was emptied by lavage just before being replaced in the stomach to remove the adhesions. The spleen was adherent to the stomach, and the entire opening

12 centimeters in diameter and extended to within 1.25 centimeters of the esophageal opening. I then attempted to repair the opening with interrupted sutures of catgut but the opening was so large and there was so much tension on the sutures during the movement of the diaphragm that the sutures would not hold. Phrenicotomy was then performed which relaxed the diaphragmatic muscle. Following this closure of the opening was satisfactory. The posterior margin was lapped over the anterior margin for 2.5 centimeters at the median portion to 2.5 centimeters at the outer angle. Interrupted sutures both of catgut and of linen were used. Before the opening was completely closed a No. 24 French catheter was introduced through a trochar and cannula into the cavity and left in the lower left part of the thorax. This closed drainage was instituted to take off the blood and serum which would result from general oozing where the many adhesions had been separated.

There was considerable shock following the operation. On the second postoperative day the temperature was 102 degrees F. and the pulse rate 110. Respirations varied from 18 to 22. The temperature and pulse had gradually dropped to normal by the seventh day. The thoracic cavity was aspirated daily, from 100 to 200 cubic centimeters of bloody fluid was removed and the tube was removed on the ninth day. The patient was dismissed from the hospital on the twenty second day and from observation on the twenty seventh day, at which time the wound was entirely healed and the left lung was fully expanded. In reply to a questionnaire 4 years after operation he stated that his general condition was good and that he has been completely relieved of his previous symptoms.

A gunshot wound not uncommonly perforates the diaphragm and if the patient survives other complications associated with the injury, a diaphragmatic hernia will develop later. The injury is more in the nature of a rent than it is of a penetrating wound. This rent is enlarged by the motion of the diaphragm. It is difficult to determine definitely when the symptoms of diaphragmatic hernia appeared in this case, as the patient had had two operations within 6 months of the injury, after which he had been in good health for about 2 years except for an indefinite attack of epigastric distress. It is probable that the opening in the diaphragm was present from the time of the injury and that the stomach was only slightly caught in the opening at irregular intervals, giving only mild distress, and that for the greater portion of the time it was in normal position below the diaphragm. For the one and a half years previous to the operation done at the clinic the stomach, apparently, had been more or less constantly herniated through the opening. The rapid progress of symptoms would indicate that adhesions had fixed the stomach in the thorax and that the increased gastric pressure and negative thoracic pressure had rapidly drawn the entire stomach into the thorax, where it had become adherent. Vomiting of blood was associated only with the most severe attacks, particularly with

the peculiar attack which the patient had at the time of his admission to the clinic. Gastric erosion was superficial and resulted from the forceful vomiting acting on the dilated and congested gastric wall. This was evidenced by the fact that no definite thinning out of the gastric mucosa was noted at the time of operation, although it may have been present. The stomach was so congested and edematous from the recent acute incarceration that a small area of ulceration could easily have been overlooked. The operative procedure is of interest in this case. The opening was so large, practically circular in character, that it was impossible to overlap or even approximate the margins of the opening without the stitches pulling through the tissues during contraction of the diaphragmatic muscle. The cutting of the phrenic nerve immediately stopped the contractions, and the margins could be overlapped without undue tension. The surgical principles of early repair are the same in the diaphragm as they are in the inguinal region or in the abdominal wall, that is accurate approximation of tissues without tension, and I believe it is of greatest importance in the diaphragm, as this muscle is constantly in motion. The atrophic change, after cutting of the nerve, does not interfere with the blood supply sufficiently to delay healing as has been demonstrated, experimentally, on animals by effectiveness of the healing. This is exemplified in the case as it has now been 4 years since operation and there has been no recurrence of the hernia.

CASE 8. A man aged 35 years was admitted to the clinic October 4, 1923, complaining of trouble with the stomach of 6 years duration. Light years previous to his admission he had fallen from the top of an embankment 16 feet high landing on a cement floor on his feet. He had fractured one bone in the right leg and had torn the ligaments of the left leg. Both legs had been placed in splints for 4 weeks and he had been unable to work for 8 weeks. During this period he had had some mild indigestion immediately after meals but nothing definite and the trouble had been attributed to constipation and inactivity. One and a half years later, he had had pains in the left side of the thorax after meals with associated pain in the front of the left shoulder. This had been progressive and had been associated with dyspnea on exertion. About 6 years before he came to the clinic this gastric distress had become more or less constant particularly following the evening meal which usually was heavy. By this time the distress was associated with pain in the thorax and shoulder. Two and a half years ago he said he had had a severe attack which had lasted a week and which had been associated with nausea, vomiting and cramping pains in the abdomen and sharp pain referred to the left shoulder. Since that time he had had repeated attacks of similar pain coming on usually from 1 to 2 hours after meals and lasting until the next meal. He would have pain immediately after eating. A glass of milk or food would cause pain in the left side of

the thorax, through to the angle of the scapula, and there would be an associated pain in the left shoulder radiating down the left arm. Three months before he presented himself for examination, he had vomited a large quantity of blood and he thought that he had passed blood in his stool. He had been hospitalized and had been given a Sippy diet, with slight improvement. Up to the time of examination he had lost 40 pounds in weight.

Examination gave essentially negative results except for loss of weight and abnormal symptoms in the left side of the thorax. The systolic blood pressure was 105 and the diastolic 60. Urinalysis was negative. Examination of the blood revealed a concentration of haemoglobin of 71 per cent, erythrocytes numbered 4,520,000 and leucocytes 6,100 in each cubic millimeter of blood. Analysis of gastric content revealed total acidity of 42 and free hydrochloric acid of 24. The quantity of content recovered was 100 cubic centimeters. Roentgenograms revealed that almost the entire stomach was above the diaphragm. Fluoroscopic examination of the thorax showed a large opening in the left part of the dome of the diaphragm, posterior to the oesophageal opening. A diagnosis was made of left diaphragmatic hernia with herniation of practically the entire stomach into the left thoracic cavity through an opening in the posterior leaf of the left part of the diaphragm, close to the oesophageal hiatus. Gastric erosion was found to be present at the point of angulation.

October 10, 1928. I performed preliminary left phrenotomy and 3 days later repaired the opening in the left leaf of the diaphragm. When the upper part of the abdomen was exposed, many adhesions were found around the diaphragm, and only about 5 centimeters of the pyloric end of the stomach was in the abdominal cavity. The remaining portion of the stomach was in the left half of the thorax together with the omentum and a portion of the transverse colon. The omentum and stomach were firmly adherent to the entire margin of the opening in the diaphragm, which was elliptical in shape, about 10 centimeters in diameter, and extended from about 2.5 centimeters to the left of the oesophageal opening downward and backward. After the adhesions were freed from the margin of the opening, the colon could be removed from the thoracic cavity but the stomach and omentum could not be brought into the abdominal cavity because of firm adhesions to the pericardium and under surface of the lung. It was necessary to dissect the entire stomach away from these structures. A portion of the omentum could not be entirely removed without injuring the pericardium and lung, therefore, it was ligated and left in the thoracic cavity. There was marked scarring of the stomach on the lesser curvature at the angle where it rested against the ring of the hernia and there was evidence of shallow ulceration which probably was traumatic, due to angulation of the stomach. During dissection of the adhesions from this thinned out area of the stomach a small opening was made into the stomach. This opening was immediately closed with interrupted catgut sutures and the closure was reinforced with a fold of the proximal part of the omentum. After the abdominal viscera had been replaced in the abdomen the large elliptical rent in the diaphragm was repaired by overlapping the anterior portion over the posterior margin for a distance of about 2 centimeters. Satisfactory closure of the deficiency

in the diaphragm was made with interrupted linen sutures. The patient stood the operation satisfactorily and convalescence was uneventful. In reply to a recent questionnaire, he stated that his general condition is fair and that he has been completely relieved of previous symptoms but occasionally he has pain about 5 centimeters to the left of the abdominal incision, coming on mostly at night, about 5 to 6 hours after he goes to bed, which is relieved by urination.

The patient returned for observation 4 months after operation, the roentgenogram of the stomach at that time showed it to be in normal position below the diaphragm. There was no demonstrable lesion in the stomach or duodenum. Urinalysis, at that time, was negative except for a few pus cells. He had gained 30 pounds in weight (Figs 15 and 16).

The clinical history in this case is of interest. It was impossible to determine definitely the relationship of the trauma to the diaphragmatic hernia, there were no definite symptoms until at least 1½ years after the injury. The symptoms from that time were progressive and were associated with severe attacks of incarceration which resulted in vomiting. There was blood in the vomitus. These attacks undoubtedly were caused by a spasm of the diaphragm with a reflex pain in the left shoulder and down the arm. Constant traumatizing of the stomach had caused sufficient erosion and ulceration of the mucosa to cause pain, the history of which was that it came on 1 to 2 hours after meals and was relieved by the taking of food, the pain was fairly typical of gastric ulcer. This, together with the hernia, gives a significant combination of symptoms, that is, the taking of food would relieve the type of pain that was characteristic of ulcer but more likely would bring on the more severe attacks caused by the herniated stomach, this latter pain was accompanied by spasm of the diaphragm and reflex cardiospasm. Because of the patient's inability to take sufficient nourishment and the constant vomiting for 3 months, he had lost 40 pounds in weight. Erosion of the gastric mucosa was found at operation. The gastric wall was so thin at the point of angulation that the stomach was opened during its dissection from the surrounding structures. There was no induration about this area, such as is found in the ordinary inflammatory gastric ulcer, and the fact that he has had no further hemorrhage or complaint of ulcer following repair of the hernia, is very good evidence that this ulceration was of traumatic origin.

# THE CONTROL OF MORBIDITY AND MORTALITY FOLLOWING PELVIC SURGERY<sup>1</sup>

A REVIEW OF ONE THOUSAND CONSECUTIVE PERSONAL CASES

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**I**n these days of aseptic technique, the post-operative survival of the patient no longer constitutes a surgical triumph. Expert anesthesia and modern operating room facilities have so reduced the hazards of pelvic surgery that even the gynecological tyro may perform ill advised or incomplete operations without much fear of a catastrophe. A truly satisfactory operative result implies not only conservation of the patient's life, but also an uneventful convalescence and subsequent complete symptomatic relief. An introspective analysis of a series of personal cases, with particular reference to the two latter items, is a fair index of an operator's pre-operative preparation of his patients, his surgical judgment and his skill in post-operative treatment. For many years I have made it a practice at regular intervals to scrutinize the results of successive groups of my own operative cases, not for publication, but hoping to profit thereby.

Individualities can never be standardized and there are bound to be factors involved in the treatment of patients by different members of the same hospital staff. Personal experiences are much more enlightening than the array of a large mass of statistical data taken from the records indiscriminately. We can teach others operative technique, but we cannot endow them with dexterity, we can inculcate surgical judgment, but we cannot assure its exercise, and we can outline principles for postoperative treatment, but the responsibility for their application must always devolve upon the one in actual attendance upon the patient. Hence, I believe that it is unfair to appropriate another's successes or include his failures in the assay of a series of end results.

It has been said that statistics may be made to prove anything, even the truth. The corollary of this innuendo is that occasionally they may prove of value. I have therefore presumed to utilize my last 1000 personal operative cases immediately preceding January 1, 1930, as a basis for this presentation. This group includes those admitted to my ward service at the New York Post Graduate Hospital, as well as private

patients. There were complications during convalescence in 79 cases, a morbidity of 7.9 per cent, 19 patients died, a mortality of 1.9 per cent (Table I).

TABLE I—MORBIDITY AND MORTALITY

Consecutive gynecological cases	1000
Postoperative complications	79
Morbidity per cent	7.9
Postoperative deaths	19
Mortality per cent	1.9

Of course, a few patients had multiple complications so that the incidence of complications is slightly higher than the morbidity percentage.

The purpose of this inquiry is to ascertain the caliber of the pre-operative study and preparation of the patients, whether or not the morbidity was as low as it should have been, and whether or not any of the fatalities could have been avoided.

## PRE-OPERATIVE PROTECTIVE MEASURES

My pre-operative survey of the patient embraces an adequate history, a careful physical inventory, appropriate laboratory tests, and the exercise of special care to investigate the possible remote causes of pelvic symptoms. No laboratory examinations are done as a matter of routine. Such practices impose an unnecessary burden on the institution and subject the patient to needless expense. Intellectual honesty suggests that no operation is ever justified unless it is certain that symptomatic relief or cure is otherwise impossible. Averaging more than 3000 new patients per year in the gynecological clinic of the Post Graduate Hospital, our operative incidence is a little less than 8 per cent.

Catheterized urine is collected in a sterile ignition tube from each new patient, and examined microscopically and microscopically. This provides a non-contaminated specimen, suitable for culture. Indicanuria, bacteriuria, and obstinate constipation are indications for thorough pre-operative intestinal cleansing. The colon is unloaded by means of milk of magnesia, mineral oil, and enemata, but cathartics are shunned. All patients are encouraged to drink water freely up to the time of operation.

<sup>1</sup>Read before the Brooklyn Gynecological Society, Brooklyn, April 4, 1930.

Candidates for elective operations are cystoscoped, and an indigo-carminic renal function test is done on those having pain in either hypochondriac or lumbar regions. These precautions will preclude useless appendectomy or oophorectomy for trivial pathological alterations, when the symptoms are really due to ureteral stricture, chronic pyelitis, calculus, etc.

Smears are taken from the urethra, vagina, and cervix in all patients having leucorrhœa. The presence of pyogenic micro-organisms is an indication for postponing operation.

Biopsy specimens are removed with surgical diathermy from every eroded, ulcerated, or indurated cervix, in order that early malignancy may never be overlooked.

A complete blood count and sedimentation time test are done on patients with pyrexia or other manifestations of an inflammatory process. Every patient with hæmoglobin of less than 65 per cent or with a red cell count of less than 3,500,000 is transfused before operation. Post-operative transfusion should never be required in an elective case except in the presence of ectopic pregnancy, secondary hæmorrhage, or sepsis.

Red spongy gums, or other evidence of pyorrhœa, justify postponing operation until after a course of oral hygiene. Acute parotitis, always distressing and often fatal, does not occur when the mouth and teeth are clean.

It is unwise to operate upon a patient suffering from coryza, cough, or hoarseness except in an emergency, and then only under spinal anesthesia.

When there is evidence of cardiac functional disturbance, an electrocardiogram is made. Patients with marked lengthening of conduction time are put to bed and digitalized before operation.

Pronounced arterial hypertension, renal lesions, or impaired metabolism, especially with abnormal hæmatogenous retention of nitrogenous waste products, are indications for pre-operative treatment, spinal anesthesia, and prompt post-operative chemotherapy with glucose, alkalis, or chlorides, as the case may be. A knowledge of the carbon dioxide combining power of the blood is of paramount importance in these cases.

#### AFTER CARE

*Abdominal wounds.* The dressings on undrained clean wounds are not disturbed for 8 days. If a small gutta percha drain has been placed beneath the fat in a stout woman, it is withdrawn on the fifth day.

*Vaginal plastic wounds* are kept dry and dusted with aristol for 7 days. Douches interfere with

primary union and serve no useful purpose. The bladder is catheterized every 6 hours for 3 days irrespective of the inclination to void, to prevent wound contamination, to preclude pressure on the suture lines by a distended bladder, and to insure the absence of residual urine. I have no fear of an aseptic catheterization exciting a cystitis, but I regard residual urine as a potential source of infection. Hysterectomy cases and all others in which the bladder has been subjected to trauma are similarly catheterized for the same reasons. Hexamethylenamine and acid sodium phosphate are started promptly in catheterized patients. If non-absorbable sutures have been used, they are removed on the tenth day.

*Drains.* Gauze strips and cigarette drains which have been placed to protect raw surfaces or to provide for slight oozing are removed in 48 hours. Those inserted because of suppuration are shortened gradually.

*Curettage cases.* After the uterus is curetted, a strip of narrow iodoform gauze is packed into the uterine cavity, the uterus replaced bimanually, and the patient given 0.5 cubic centimeter of pituitrin intramuscularly. These measures promote rapid uterine involution and tend to prevent retrodisplacement.

*Radium cases.* The vagina is packed tightly with iodoform gauze to dislocate the bladder and rectum, and the bladder is drained continuously with a Pezzer catheter while the radium is *in situ*. Immediately following the removal of the radium, gauze, and catheter, the patient is given an enema and a douche. Having always employed these precautionary measures, no fistulæ have appeared in my radium cases.

*Fistula cases.* In all cases of vesicovaginal and urethrovaginal fistula, an indwelling catheter is left in place for 10 to 14 days. The catheter is flushed daily with 2 per cent boric acid solution, and a urinary antiseptic given until it is removed. Rectovaginal fistulæ are protected like complete perineal tears, by restricting the diet to fluids and constipating the patient for 8 days.

*General prophylactic measures.* Autolavage, gastric lavage, and the duodenal tube are used early if vomiting is at all persistent.

A rectal tube is inserted on the second day, but enemata are withheld until the third day. Enemata and colonic irrigations are used freely but cathartics are avoided as much as possible while the patient is confined to bed. Considerable time must elapse before the intestinal tract regains its tonicity, and functional restoration will only be further delayed if overstimulated while incapable of a normal response.



All patients are encouraged to move their arms and legs voluntarily and change their position at frequent intervals early in their convalescence. This is good insurance against post-operative embolism.

Patients subjected to prolonged anaesthesia (more than 1 hour) or manifesting the danger signals of impending shock are given 1000 cubic centimeters of 5 per cent glucose by hypodermoclysis or intravenous injection as soon as they are returned to bed. Hypertonic saline solutions are also of value, if there is no tendency to acidosis.

#### POSTOPERATIVE MORBIDITY

Having outlined briefly the more important details of the precautionary measures employed to obtain satisfactory results after gynecological operations their actual value should be evident from an examination of the incidence of post-operative complications (Table II). As already stated, some patients had multiple complications, hence the incidence of complications 86 per cent, is slightly higher than the morbidity 79 per cent.

TABLE II—POSTOPERATIVE COMPLICATIONS

	Cases
Gastro intestinal	20
Pulmonary	17
Infected wounds	16
Urinary	12
Cardiovascular	11
Systemic	7
Postoperative hemorrhage	3
Total	86

TABLE III—GASTRO INTESTINAL COMPLICATIONS

	Cases
Faecal fistula	6
Acute peritonitis	5
Acute intestinal obstruction	3
Pseudo ileus	2
Paralytic ileus	1
Duodenal fistula	1
Acute dilatation of the stomach	1
Acute parotitis	1
Total	20

A faecal fistula established itself in 6 cases, invariably following severe and extensive pelvic suppuration. One patient had diabetes and carcinoma of the caecum, one had a combination of fibroids, tubo ovarian abscesses, and cancer of the cervix with metastases, one had been recently treated with X-ray in another hospital on an erroneous diagnosis of fibroid, and one had been treated by another gynecologist with diathermy for a supposed parametritis. Two other patients developed a fistula as a result of dense

adhesions between pus tubes and the rectosigmoid. The first mentioned two patients died, in the others, the fistula closed spontaneously. These cases emphasize the fact that radiation and diathermy are dangerous in the presence of active or latent tubal infection.

Acute peritonitis supervened 5 times, 3 times within 24 hours after a radium application for cancer of the cervix, and one patient died. Evidently I had failed to detect a co-existing salpingitis in these women. The fourth case is inexplicable, as the autopsy did not reveal any focus of infection or weak spot in the intestinal wall, and the operation consisted of plastic repair, appendectomy, and uterine suspension. The fifth patient died of peritonitis after an exploratory laparotomy for carcinoma of the ovary with general abdominal carcinomatosis. In this group of cases too, the hyperaemia incidental to radiation when a salpingitis was present was responsible for subsequent disaster.

Mechanical intestinal obstruction followed hysterectomy twice and salpingo-oophorectomy twice, on the fifth, seventh, sixteenth, and twenty third days, respectively. In each instance a loop of ileum was found adherent to the infundibulopelvic suture line. One cannot be too careful in peritonealizing raw surfaces and burying all knots when pelvic organs are removed. A concomitant volvulus was found in 1 case and the patient died despite an ileostomy.

Pseudo ileus occurred in 2 cases and was promptly relieved by an intramuscular injection of pituitrin, followed in 10 minutes with 7 soap suds enema containing peppermint and turpentine.

Paralytic ileus developed suddenly on the fifth postoperative day during an apparently normal convalescence after salpingectomy for a huge haematosalpinx. Precipitate vomiting, rupture of the abdominal wound, and eversion of two loops of gut were followed by death in 50 minutes.

A duodenal fistula manifested itself 48 hours after a cholecystectomy for empyema of the gall bladder in a desperately ill patient, and the patient died on the sixth day.

The case of acute parotitis occurred early in this series and was the first and only one in my practice. It appeared 3 days after a plastic repair and salpingectomy, and was deeply incised despite the absence of frank suppuration. Although recovery followed, the patient's distress and her alarming condition made a lasting impression. Before this experience I had paid little attention to pre-operative mouth cleanliness, since then I have insisted upon it.

Had I detected the co existing pus tubes in the 3 cancer of the cervix cases, perhaps exercised a little more care in peritonealization in the 4 cases of intestinal obstruction, and insisted upon pre operative mouth cleanliness in the patient who developed parotitis, I might have reduced the incidence of gastro intestinal complications from 20 to 12, and possibly prevented 2 deaths

TABLE IV —PULMONARY COMPLICATIONS

	Cases
Pneumonia	12
Acute pulmonary oedema	2
Pleurisy	1
Empyema	1
Pulmonary infarcts	1
Total	17

Of the pneumonias, 7 were bronchial, 3 lobar, 1 influenza, and 1 hypostatic. The hypostatic pneumonia developed in an elderly, undernourished, asthenic woman with a fibroid reaching the diaphragm, and terminated fatally on the twelfth day after operation. The influenza pneumonia, together with acute splenitis and acute nephritis, provided a surprise at autopsy on a woman of 28 years who died suddenly, 12 hours after a diagnostic curettage for menorrhagia. She was free from pulmonary and renal symptoms both before and after the 6 minute operation, which was done under gas-oxygen anaesthesia.

Bronchopneumonia followed hysterectomy 4 times, and plastic and suspension operations 3 times, and terminated fatally in 1 case. All 3 patients having lobar pneumonia recovered. Perhaps the most significant observation made in these cases is the notation that 8 of the 12 pneumonias developed in ward patients, to whom anaesthetics were administered by less experienced anaesthetists, while only 4 occurred in private patients, and 2 of the latter were desperately ill when operated upon. Spinal anaesthesia was employed 41 times in this series without a subsequent pneumonia.

Acute pulmonary oedema was characterized by its sudden onset in 2 ward cases of acute appendicitis (one with tubo-ovarian abscess), and although one patient recovered, the other died 7 hours after operation. The latter was regarded as an anaesthetic death. The anaesthetist evidently failed to recognize the signs of pulmonary irritation during operation, and neglected to change the rebreathing apparatus for an open ether cone. The patient was cyanotic almost continuously after operation until death, despite all restorative measures.

The single case of pleurisy also occurred in a ward patient after a rather long anaesthesia.

Empyema developed after a lobar pneumonia on the twenty-fifth postoperative day, following an emergency operation on an intensely septic patient. She recovered.

A series of pulmonary infarcts prolonged the convalescence of one patient after a simple plastic repair.

To summarize, 11 of the 17 pulmonary complications were noted in ward patients, who were afforded the services of less experienced anaesthetists. It seems fair to infer that the training of a large number of anaesthetists involves the risk of an increased number of pulmonary complications.

TABLE V —INFECTED WOUNDS

	Cases
Abdominal	13
Perineal	3
Total	16

An abdominal wound was regarded as infected if primary union failed to occur in a clean case, irrespective of the cause. In 1 case, a persistent sinus drained for 30 days because of the presence of a small piece of gutta percha tissue, which evidently had broken off when the subcutaneous drain was removed on the fifth day. Another wound opened widely as a result of syphilitic necrobiosis following an imperative operation. So far as I know, there were only two subsequent ventral hernias in the group of 13 infected abdominal wounds and 1 of these was due to the strain of terrific coughing. Although I always make a mid-line incision, the fascia is opened to the left, and the left rectus muscle is pushed off the linea alba. Thus, the incision is zig zagged from without in.

Superficial perineal sutures broke down in 3 cases, but the ultimate results were satisfactory. Uniting the vaginal fibers of the levator ani muscle with kangaroo tendon insures the integrity of the restored perineal body even though the superficial suture line gives way.

TABLE VI —URINARY COMPLICATIONS

	Cases
Acute pyelitis	8
Cystitis	3
Suprapubic urinary fistula	1
Total	12

Six of the 8 cases of acute pyelitis occurred before I appreciated the significance of the pre-operative symptom-complex of indicanuria and obstinate constipation. They were all character-

ized by a pyrexia between the tenth and eighteenth postoperative days, and were accompanied by nausea, lumbar pain, urinary turbidity, or headache. All patients had colon bacilli in the urine.

The incidence of cystitis was low, only 3 cases. Of course, cases of simple bladder irritation without actual inflammatory changes in the vesical wall are not included in this group.

After a hysterectomy for fibroid, the abdominal wound dressing became wet and malodorous on the eighth day. The odor was urinary, and the oral administration of methylene blue verified the diagnosis of suprapubic urinary fistula. The needle used to close the peritoneum had evidently inadvertently perforated the bladder. A retention catheter was introduced into the bladder and the fistula closed spontaneously 8 days later.

It would seem that in the absence of concomitant lesions in the urogenital tract, nearly all urinary complications after pelvic operations are preventable.

TABLE VII—CARDIOVASCULAR COMPLICATIONS

	Cases
Thrombophlebitis	4
Embolism	3
Tachycardia	2
Acute cardiac dilatation	1
Auricular fibrillation	1
Total	11

Thrombophlebitis followed laparotomy 4 times, 3 times after hysterectomy and once after a plastic repair and uterine suspension. All 4 patients recovered.

Although there were 179 abdominal hysterectomies in this series of 1000 cases, and all were done rapidly with clamps, sudden death from embolism followed but once, and in this case there was co-existing intestinal obstruction at the time of operation. The patient died suddenly on the eleventh day from bilateral pulmonary emboli. Autopsy revealed a large clot in the left femoral vein. Two other patients died suddenly from cerebral embolism, one on the seventh day after a uterine suspension and appendectomy, and another 90 hours after an exploratory incision for massive general abdominal carcinomatosis, primary in the ovary. None of these patients could be persuaded to practice active motion of the extremities.

Two cases of mysterious tachycardia were of more than passing interest. In the first instance, a young woman was subjected to a plastic repair, suspension, and appendectomy, under a smooth

general anesthesia. She reacted normally, but 2 hours later her pulse rate jumped from 100 to 150 without any other subjective or objective symptoms. This continued for 30 hours and then gradually decreased to 110, where it remained for 8 days. Repeated cardiac examinations, electrocardiograms, basal metabolism tests, etc., failed to disclose the cause. Similar operative procedures had been planned for another woman of 42. After doing an anterior colporrhaphy and almost completing a perineorrhaphy, the anæsthetist reported an increase in the pulse rate from 80 to 140 at the end of 25 minutes, although the quality of the pulse and the patient's respiration were good. The laparotomy was postponed and the patient returned to bed. Within 4 hours the pulse rate dropped to 100. A thorough medical check up failed to reveal an explanatory cause. The laparotomy was done 10 days later, and the tachycardia recurred after 20 minutes. The operation was completed within half an hour and recovery was uneventful. Within a month after this observation one of my assistants had a similar experience. Unfortunately, he disregarded the danger signal and was lulled into a sense of false security by the pulse quality, respiratory rate, and the patient's color. His patient died as he was closing the abdominal incision.

The only case of acute cardiac dilatation occurred 8 days after a 6 minute gas oxygen anesthesia for the intra uterine application of radium to a fibroid growing in a uterus after an interposition operation (done in another hospital). There was no pre-operative evidence of cardiac disease and subsequent recovery was complete.

Another radium application for the treatment of a small bleeding myoma was followed in 12 hours by auricular fibrillation. It subsided in 6 days under appropriate therapy.

None of these cardiovascular complications seem to have been preventable.

TABLE VIII—SYSTEMIC COMPLICATIONS

	Cases
Surgical shock	2
Acidosis	2
Uremia	1
Alkalosis	1
Thyrototoxicosis	1
Total	7

The 2 cases of surgical shock occurred in profoundly septic patients. The first had acute suppurative appendicitis with bilateral tubo-ovarian abscesses, and died in 11 hours. The other had a fulminating pelvic peritonitis following diathermy treatment by another gynecologist.

for pyosalpinx. Four hours after operation she was pulseless. Intravenous digitalis, infusions, coffee enemas, etc., sustained her through the night. Early the next morning she was transfused. Septic pneumonia on the third day, faecal fistula on the sixth day, empyema, and thoracotomy on the twenty fifth day, were followed by eventual recovery.

Acidosis resulted fatally on the eighteenth day in a diabetic patient with a carcinoma of the caecum, on whom I did an ileostomy under spinal anaesthesia. Another fatality on the fifth day from the same cause followed a hysterectomy under spinal anaesthesia. Chemotherapy and insulin were of no avail in either instance.

An elderly woman died of uræmia 3 days after the removal of a huge fibromyomatous mass. The urinary nitrogenous output was low and the nitrogenous retention in the blood high, but œdema of the legs and respiratory embarrassment were so distressing that a hysterectomy was done after a month's preliminary treatment.

The only death from alkalosis occurred on the seventh day after a hysterectomy for the largest fibroid tumor encountered in this series of cases. It was preceded by adynamic ileus. Fortunately, no alkalis had been used as a routine measure in the postoperative treatment.

Acute thyrotoxicosis developed promptly after a radium application for carcinoma of the cervix in a patient with a basal metabolism of plus 26. She had consulted a general surgeon, prepared for a thyroidectomy. He discovered the co existing carcinoma and referred her for radium treatment. Re-examination of the blood after 24 hours showed an insignificant increase in the urea nitrogen and carbon dioxide combining power, but the systolic blood pressure rose from 150 to 208. The clinical picture was that of a patient with a toxic goiter who had been given thyroxin.

TABLE IV.—POSTOPERATIVE HÆMORRHAGE.

	Cases
Postoperative hæmorrhage	3

There were three postoperative hæmorrhages, one massive intraperitoneal hæmorrhage immediately preceding death in a case of extensive pelvic cancer, another on the seventh day after a Sturmdorff tracheloplasty, easily controlled with packing, and a third 6 hours after a vaginal myomectomy, arrested by means of secondary sutures. The last patient required postoperative transfusion, as did 2 septic cases. These were the only 3 postoperative transfusions necessary in a series of 1000 operations.

Scrutinizing the mortality list, it does not seem

unreasonable to imagine that the number of deaths might have been reduced from 19 to 14. More skilful anaesthesia might have prevented the fifth and nineteenth disasters. In the eighth case, additional pre operative reduction of the basal metabolic rate might have avoided the acute thyrotoxicosis. In the tenth case, a pre-radiation diagnosis of active salpingitis might have prevented the subsequent pelvic peritonitis, faecal fistula, and secondary hæmorrhage. In the twelfth case, the bronchopneumonia must have been present at the time of operation, although the patient was symptomless, and nothing abnormal was found on physical examination.

#### SUMMARY AND CONCLUSIONS

1 In a series of 1000 consecutive gynecological operative cases, there were complications during convalescence in 79, a morbidity of 7.9 per cent, 19 patients died, a mortality of 1.9 per cent.

2 Postoperative transfusion should never be necessary except in the presence of ectopic pregnancy, secondary hæmorrhage, or sepsis.

3 Pre operative cystoscopy and renal function tests will eliminate many useless pelvic operations.

4 Severe anaemia, pyorrhœa, respiratory affections, a compromised myocardium, arterial hypertension, and impaired metabolism are indications for postponing operation in elective cases, spinal anaesthesia may reduce the hazards in emergency cases.

5 Radiation and diathermy are dangerous in the presence of active infection or necrobiosis.

6 Meticulous peritonealization and burying all suture knots minimizes the likelihood of post-operative intestinal obstruction.

7 The incidence of pulmonary complications can be lessened by the invariable employment of a skilled anaesthetist.

8 Correcting indicanuria and obstinate constipation before operation will practically eliminate postoperative pyelitis.

9 Persuading the patient to practice active motion of the extremities throughout convalescence is good insurance against thrombophlebitis and embolism.

10 Pronounced tachycardia developing during the first half hour of anaesthesia is an indication to terminate the operation as soon as possible.

11 Unpreventable surgical shock will develop occasionally in profoundly septic patients.

12 Patients with a high metabolic rate should not be subjected to radiation.

TABLE X.—MORTALITY IN ONE THOUSAND CONSECUTIVE GYNECOLOGICAL OPERATIONS

No	Diagnosis	Operation	Cause of death
1	Large hematosalpinx and intraligamentary cyst	Salpingo-oophorectomy cystectomy appendectomy	Suffien paralytic ileus and death 5th day (autopsy)
2	Large calcareous fibroid impaired metabolism massive edema of legs from pressure	Supravaginal hysterectomy	Death from uremia 3rd day
3	Large fibroid in emaciated elderly woman	Supravaginal hysterectomy and salpingo-oophorectomy	Death from hypostatic pneumonia 14th day
4	Empyema of gall bladder Temperature 105 pulse 130	Cholecystectomy	Duodenal fistula in 48 hours Death from exhaustion 6th day
5	Lacerated and polypoid cervix, rectocele retroversion chronic appendicitis	Trachelorrhaphy perineorrhaphy Gilliam suspension appendectomy	Bronchopneumonia in 54 hours Death 3rd day (autopsy)
6	Acute suppurative appendicitis bilateral tubo-ovarian abscess	Appendectomy salpingo-oophorectomy	Postoperative shock Death in 11 hours (autopsy)
7	Large fundal and intraligamentous fibroid	Supravaginal hysterectomy salpingo-oophorectomy	Atynamic ileus Death from alkalosis 7th day
8	Carcinoma of cervix toxic goiter (basal metabolism plus 36)	Intra-uterine transfusion with radium needles and intra uterine radium application	Acute thyrotoxicosis in 24 hours Death in 48 hours
9	Retroversion	Billy Webster suspension appendectomy	Cerebral embolism and death 7th day (autopsy)
10	Carcinoma of cervix retroperitoneal metastases bilateral tubo-ovarian abscess	Radium application (trans fundus and laparotomy 12th day)	Fecal fistula 4th day urticaria 7th day secondary hemorrhage and death 34th day (autopsy)
11	Carcinoma of caecum and diabetes	Ileostomy (spinal anesthesia)	Hyperglycemia and death from acidosis, 14th day
12	Hyperplasia of endometrium (negative pre-operative physical findings)	Corettage	Suffien death in 12 hours Bronchopneumonia acute nephritis and acute splenitis found at autopsy
13	Extensive inoperable abdominal carcinoma tosis	Exploratory laparotomy (spinal anesthesia)	Cerebral embolus and death 90 hours.
14	Lacerated cervix rectocele chronic salpingitis chronic appendicitis	Tracheloplasty, perineorrhaphy salpingectomy appendectomy	Acute suppurative peritonitis 24 hours Death 80 hours (autopsy)
15	Adenomyosis of uterus salpingo-oophoritis pelvic peritonitis chronic appendicitis	Supravaginal hysterectomy salpingo-oophorectomy appendectomy	Acute intestinal obstruction and ileostomy 7th day Death from exhaustion 15th day (autopsy)
16	Fibroid ovarian cyst extensive pelvic adhesions	Supravaginal hysterectomy, salpingo-oophorectomy mobilization of viscera (spinal anesthesia)	Patient irrational and uncontrollable in 35 hours Died of acidosis 5th day
17	Intestinal obstruction fibroid ovarian cyst	Supravaginal hysterectomy salpingo-oophorectomy	After smooth convalescence sudden death from pulmonary embolus 11th day (autopsy)
18	Extensive inoperable abdominal carcinoma tosis	Exploratory laparotomy	Diffuse peritonitis Death 7th day
19	Acute suppurative appendicitis	Appendectomy	Acute pulmonary edema Death 7 hours

13 The control of postoperative morbidity and mortality following gynecological operations is contingent upon conscientious pre operative

preparation of the patient, expert anesthesia, sound surgical judgment, and skillful after treatment

AN OPINION ON THE PRESENT HIGH OPERATIVE MORTALITY IN ACUTE APPENDICITIS<sup>1</sup>

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**I**F the question "What class of operations gives you most concern?" were put to a body of surgeons, I believe that all would reply, "the bad appendix case." My experience would prompt the same answer. By the bad appendix case, I mean the patient with the acute perforated appendix, the patient with the unrecognized gangrenous appendix, or the patient who is the victim of extensive suppuration. Any one of these necessarily enters the hospital with a peritonitis and may already be in a terminal toxic condition. The peritonitis may be either circumscribing or circumscribed, diffusing or diffused, the temperature normal, moderately high or very high, the pulse slow, weak, or rapid, the skin of the face and fingers cyanotic, the leucocyte count high or low with either a normal or a high polymorphonuclear count.

Why do we get such cases? Because the patient has been purged, because the physician has not been called in early, because if called in time he has failed to recognize the condition, or because, if he has recognized it and diagnosed it correctly, he has tried expectant treatment and has deferred operation. And why is the operative mortality high? Because the time for operation has not been well chosen or because, if opportunely timed, operation has not been complete, due either to poor surgical judgment or to lack of experience in handling these cases, or to both.

It is only by frank discussion of this vital subject that we can hope to better our results. The subject is not one for laboratory research but for personal research into the laboratory of the mind, indeed, it demands that we make a sort of search of our souls to purge ourselves of this dark spot in our conscience.

Although I fully realize that it is not necessary to discuss the signs and symptoms of appendicitis and its differential diagnosis, I would stress a few salient points which have served me well.

Most of these patients, as I have already said, enter the hospital with a peritonitis, and it is difficult to determine the causative lesion. Since the appendix is most commonly the cause, it is naturally the first and last to be considered. The presence of muscle relaxation frequently enables us by palpation and percussion to detect a mass or an area of increased resistance which may serve to direct us to the underlying cause of the per-

itonitis, but, if the rigidity is very pronounced, this is not always true. Auscultation is a very valuable means of detecting the lesion. The stormy, turbulent, and the silent belly are all significant of the stage of peritonitis, that is, whether it is circumscribing, circumscribed, diffusing or diffused. It is my habit when examining patients, first to auscultate the abdomen. This must be very gently done because should the case be a paralytic ileus, for example, pressure on the abdomen might disturb the fluid contents of the small intestines and cause a tinkling which would not be heard if auscultation had been forcefully done. I stress this point because tinkling is often an ominous sign and if not properly evaluated may cause a false impression.

In the early stage of peritoneal irritation, very delicate palpation will often elicit the presence of serous fluid. I demonstrate this almost daily to my internes and prove it on operation.

It is important to determine the position of the appendix. Usually it is located at the site of most marked tenderness and rigidity. I need not remind you that a deep pelvic position will often require deep pressure to elicit tenderness and often leads to a mistaken diagnosis of diverticulitis of the sigmoid.

The crux of the question is, of course, diagnosis. If this is properly made, it means operation. The next important consideration is the choosing of the opportune time for operation and the operative technique. These are very largely a matter of circumstances and of the surgical judgment that comes only with experience. Therefore it is difficult to formulate rigid guiding principles. I wish I had the gift of language to tell you why it is that when I am asked to see a patient with a very much distended belly which has been diagnosed intestinal obstruction, the moment I put my ear to the abdomen and lay my hands upon it I conclude that it is not an obstruction but an appendiceal peritonitis and instead of advising immediate operation I think it better to wait. Such an instance occurred only recently, and on the day following examination disclosed free serous fluid and an acutely inflamed non perforated appendix, and no obstruction. These are subtle distinctions that come with experience coupled with the serious thought that should be given to every case whether mild or otherwise.

The vital question of when to operate in the presence of acute appendicitis might be summed up in a few words before the onset of peritonitis if this is possible. If this were always possible, the present discussion would be unnecessary.

The early case of acute appendicitis demands immediate operation. The technique in such cases differs very little from that for chronic appendicitis except in the presence of effusion, exudate, or perforation. The character of the exudate is important and should be the deciding factor in the question of drainage and often as to the outcome of the case. Smears should be taken and examined immediately to determine the presence of infection and its type. The fluid may be serous, puruloid, or purulent. The serous fluid is practically always sterile and the operative procedure then is a simple appendectomy. The frankly purulent exudate contains organisms, and is easily recognized by its color and odor. A puruloid fluid, however, may or may not contain organisms. It is when the fluid is puruloid that the inexperienced surgeon often fails, especially if he neglects to make a smear and have it examined immediately. If the fluid is infectious the peritoneum must be protected and drainage properly placed. In other words, the question of drainage depends on the report as to the nature of the smear—which should be made from specimens from the immediate operative field, the surrounding field, and from distal points—and by the appearance of the peritoneum at and around the site of the lesion. When the pathological reports are negative, I do not drain except in the presence of a green peritoneum and of a subperitoneal exudate. In such cases drainage is required, since occasionally the exudate does not resolve but forms an abscess.

I do not endorse the statement that acute appendicitis always necessitates an immediate emergency operation. It is a matter of surgical judgment to decide when to operate and when not to operate, and the latter decision often requires the more judicial deliberation.

When a chill has been followed by abatement of pain, it is always an indication of the onset of gangrene which will shortly be followed by peritonitis. Chill abatement of pain, and drop in temperature are three signals that call for immediate operation. Fortunately, they occur early and are not ominous if their early recognition is followed by prompt surgery.

When to operate after peritonitis has developed depends upon the variety of peritonitis and the condition of the patient. In practically all cases of circumscribed peritonitis operation can be safely done at once with the proper technique.

In circumscribed peritonitis with abscess, immediate operation with proper technique is safe unless there are forbidding systemic or other conditions which in these days of spinal anaesthesia are not many. The technique in circumscribed peritonitis is as follows. After the peritoneum is opened the edges of the wound are lifted and retracted and the peritoneal cavity is carefully inspected for the presence of fluid and exudate. The character of the exudate especially is noted. I frequently use the sterile Cameron light at this and later stages of the operation. If there is no fluid or only serous fluid, the cæcum is located and brought into the wound and then the anterior longitudinal band, the ileocolic and the ileocaecal folds of peritoneum, the terminal ileum, and the base of the appendix are identified. The appendix is then delivered and removed. Careful dissection is required when the appendix is adherent or is in the subcecal fossa. It may be so concealed as to give the impression that it is absent. It thus becomes apparent that an exact knowledge of the anatomy of this region is conducive to a simple and safe operation. Usually the landmarks can be easily noted, but occasionally they are partially or entirely concealed by overlying coils of small bowel, by adherent great omentum or plaques of exudate that may or may not envelop the appendix. In the last named conditions I do not displace the coils of bowel, detach the omentum, or disturb the exudate until I have placed a sheet of rubber dam and a few small or several large gauze pads so that in the event of the presence of pus this will serve to prevent its spread. The object of using the rubber dam is to protect the endothelial covering of the peritoneum against irritation by the gauze pads. If pus is present upon opening the peritoneum, one or more of the small pads are unfolded and with the loose gauze the pus is mopped up before the sheet of rubber dam is introduced.

In circumscribing peritonitis, that is, in cases in which the infection shows a tendency to become localized, we employ anatomical and physiological rest, the Fowler-Murphy-Ochsner treatment, which is known in our clinic as regulation treatment. With few exceptions, the circumscribing peritonitis becomes a circumscribed peritonitis under this treatment and permits operation to be done with little risk of a fatality. When there has been a flare up and the circumscribing peritonitis has advanced to a diffusing peritonitis, we also treat it by anatomical and physiological rest, to allow the peritonitis to become localized. This takes place in a few days with, but usually without, the formation of an abscess, and then operation is carried out.



Fig 1 a, Great omentum wrapping around diseased appendix b, Great omentum covering caecum and appendix

In the presence of an abscess in the region of the ileocaecal junction, the terminal ileum is often infiltrated, thickened, stiff, with little contractility, and forms a part of the abscess cavity. Under these conditions my method of procedure is to evacuate the abscess, remove the appendix, place the drainage, then make an ileocecostomy or an ileocolostomy to prevent postoperative obstruction and to ensure a smooth convalescence. I do this very frequently and have never had cause to regret it. Failing to do so has caused me many anxious hours until the patient has recovered. However, this practice is for the expert and not for the surgeon of limited experience in abdominal infection. The maxim in visceral surgery—to cut well, sew well, and get well, is particularly applicable here. When the terminal ileum is only slightly infiltrated and not involved at great length, and has sufficient lumen, an anastomosis is not necessary. I cannot agree with those who claim that the bowel will always recover, for I regret, from experience in operating for obstruction a few days later, that this is not always the case.

Where an abscess is in the immediate neighborhood of the caecum and especially of the terminal ileum and when the lesion is not an abscess but is a definitely inflammatory area that would favor adhesion of that portion of the ileum so prone to

fall in contact with the abscess and thus result in an obstruction, I use a cofferdam of rather thick rubber tissue so that when I have placed it and lightly pricked the cavity within, the dam will be held up out of harm's way. Those who have many times operated for intestinal obstruction following an operation for acute appendicitis know this to be the common site of obstruction. Many a fatality has resulted due to this but has been attributed to peritonitis. I therefore cannot stress this part of the technique too strongly.

Many of you lovingly recall with me the late Dr. Joseph Price, the prince of American abdominal surgeons whose wonderful work, particularly in the pelvis was so well known and by none better than by his friend the speaker. How often would he speak of the pus as pathological soup!—an expression, I dare say, some of those present today have heard him use. Price rarely had to operate for intestinal obstruction following extensive pelvic work, much of which was for suppurative conditions. He attributed this to his thorough cofferdaming by lifting the small bowel out of the pelvis and maintaining it by this technique, thus avoiding intestinal entanglements during convalescence. I therefore gladly credit Price with this ideal and life saving procedure.

Diffusing peritonitis is a more serious affair. The diagnosis can be made by the absence of the



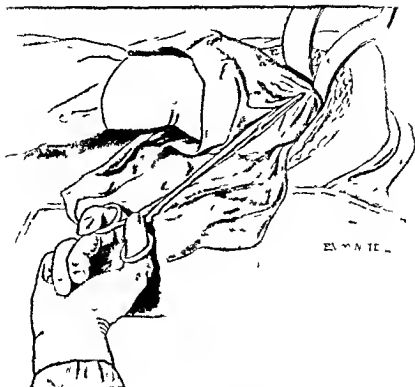


Fig. 22 Rubber dam being placed in wound

typical peritoneal facies although the patient appears very sick. The pain is very acute and the tenderness and rigidity are distributed over a larger area than in circumscribed peritonitis. Peristalsis is feeble or absent over the area of peritonitis but is exaggerated over the surrounding region. This picture, to me, indicates postponing operation until the peritoneal inflammation has subsided or has been controlled to the point of safe surgery. This stage is reached by the familiar treatment of anatomical and physiological rest.

In diffusing peritonitis much the same course is followed except that if the lesion responsible for the peritonitis can be positively determined and the peritoneal infection shows no evidence of yielding to regulation, operation is undertaken. The patient who has been operated on for an abscess will occasionally develop obstruction or a secondary collection during convalescence. Here, only timely recognition and immediate action will thwart a fatality.

Deferring operation is the best policy in the presence of diffused peritonitis, a condition which in most instances might have been prevented by timely diagnosis and treatment. This is the variety that provides the high mortality. Its ominous

signs are rigidity, and tenderness over practically the entire anterior abdominal wall, typical peritoneal facies, absence of abdominal respirations, rapid pulse, feeble peristalsis or a silent belly, moderate leucocytosis and a high polymorphonuclear count. In about 24 hours, especially if the patient has been purged, the picture changes. The rigidity and tenderness give way to distention and there is entire absence of peristalsis. The leucocytic count is low, the urinary output is diminished and the urine contains albumin and casts. The typical peritoneal facies, with restlessness and an active brain, accompanies this syndrome—a combination that usually is fatal. Occasionally regulation treatment will lead to a subsidence of the peritoneal inflammation to a point where operation is comparatively safe.

If this variety of peritonitis is seen very early, when the belly walls are still characteristically rigid, operation in the experienced hands promises most.

A collection of pus in the pelvis or in either iliac region can be evacuated by an extraperitoneal approach in the pelvis by vaginal or rectal incision, above the pubis by low midline incision after the precaution has been taken of emptying the bladder, in a subdiaphragmatic collection by

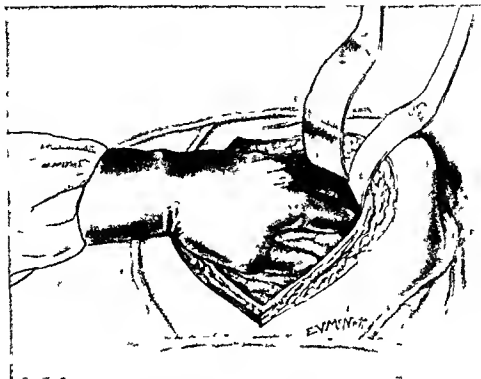


Fig 2b Gauze in place in appendectomy wound

removal of the greater portion of the tenth rib. A collection of fluid in the last-named position has been known to discharge through a bronchus. In the case of a subhepatic collection, if perchance it has extended well down into the renal well, incision through the loin will drain it, otherwise the incision should be through the anterior abdominal wall. At operation we should never forget to inspect the external paracolic furrow for pus, which if present, will call for enlarging the wound upward, exploring both the subdiaphragmatic and the subhepatic spaces and, if pus is found, drainage by rubber tube or by a cigarette drain carrying a central rubber tube will be required. We rarely see a subdiaphragmatic abscess if our technique in the primary operation has been properly carried out. The pelvis is next explored and drained if pus is found. In addition to this, a narrow 8 layer piece of gauze, long enough to reach the inner boundary of the peritoneal wound is placed between the parietal and the visceral peritoneum. The paracolic groove is loosely packed with moist gauze, and interrupted sutures of silk or silk-worm gut, preferably the former, are carried through the entire thickness of the edges of the wound and tied loosely to prevent evisceration. This leaves an open wound and permits free drainage. The purpose of the long piece of gauze between the layers of peritoneum is to excite peritoneal activity and exclusion of the general peritoneal cavity. The

question may be asked, "Why not use rubber dam for this purpose?" The answer is that rubber dam favors slipping of the intestinal coils into the wound, should the patient cough, vomit, or suddenly change his position. Silk sutures are more stable than silk-worm gut because they do not break or become untied. When pockets of pus are found between coils of bowel they are emptied and drained by strips of rubber dam or very soft rubber tubes. Nearly all these cases develop a postoperative hernia, which leads me to say, "It is better to have a patient get well with a hernia than to die without one." The time to remove the drain and gauze must be left to the discretion of the surgeon. It is better to leave them in too long than to take them out too early. I frequently say to my internes, "Let it stay in until it falls out." Figuratively speaking, this is correct, but my thought is to allow the drain to remain as long as it is not doing harm. In other words, the gauze is taken out when the interne can't stand it any longer. I wish to pay tribute to my interne staff by saying they are most efficient and capable in carrying out the postoperative treatment, so that I know the patient will be properly and judiciously handled when I am away.

I am frequently asked whether I always remove the appendix. The only case in which I do not do so is in the circumscribed abscess of several days' standing in which there is no evidence of

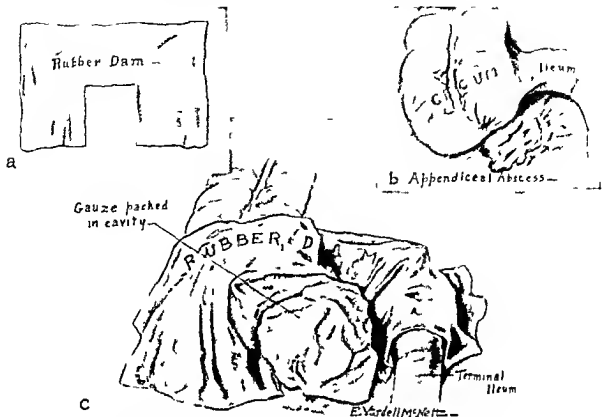


Fig 3 a Rubber dam cut to fit around gauze pack b Appendiceal abscess c Rubber dam walling off surrounding bowel

surrounding peritonitis and in which the appendix is not seen or felt. This means that the abscess cavity is absolutely isolated. However, in such cases I remove the appendix a short time after wound healing is complete. The idea formerly prevalent that in these cases the appendix has been destroyed is a myth. Except in the circumscript abscess I always remove the appendix as in many instances in doing so an abscess in close proximity is discovered which if it were not drained would lead to a serious if not a fatal complication. When there is a palpable mass in the lower right abdomen, it is my practice to make an extraperitoneal approach, the incision being carried to the outer side of the mass dividing the aponeurosis of the external oblique, the flat muscles, the internal oblique and the transversalis in the line of the incision. The transversalis fascia and preperitoneal fat, which frequently are infected, are separated from the peritoneum the latter is incised and the technique as previously described is carried out. In the presence of a large collection of pus I evacuate it, cleanse and pack the abscess cavity, isolate it from the

general peritoneal cavity, and then remove the appendix. I never use the McBurney incision in cases of acute perforated appendicitis.

In practically all of these operations spinal anesthesia is used. It makes the operator master of the situation. In some instances, in which the first injection fails, a second is made. We have now given spinal anesthesia in over 5000 cases with only one fatality, which was due to a technical error. In this case apnoea was used, since then I have used spinocain only. Inhalation anesthesia in these cases is dangerous, not only because pneumonia is more likely to follow, but if ether is used, the kidneys are endangered, since in all toxic patients renal function is more or less impaired. Nitrous oxide and oxygen anesthesia is objectionable because of insufficient relaxation and the danger of postoperative pneumonia. I have had no experience with ethylene.

My experience has forced me to discard jejunostomy and enterostomy because of the high mortality which has attended these procedures. I now use the Jutte tube and have seen a very satisfactory decrease in mortality since doing so.

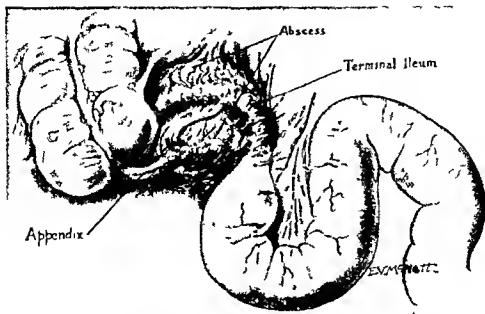


Fig 4a Appendiceal abscess indicating an ileocecostomy

The Jutte tube, which is passed through the nose, has proved to be a very valuable pre-operative and postoperative adjunct. It is one of our chief assets in postoperative treatment, not only in appendiceal peritonitis but in other forms of peritonitis as well. In fact, I pass the Jutte tube in all stomach cases while the patient is on, or shortly after leaving, the operating table. The stomach is washed out after admission to the hospital and this procedure is repeated before the patient goes on the operating table, and at the completion of the operation the Jutte tube is passed through the nose. The tube is well borne, keeps the stomach empty, prevents vomiting, and makes the patient comfortable. It permits the free administration of water without the danger of distending the stomach and waterlogging the intestines. Postoperative vomiting is not only distressing to the patient but favors the spread of infection and by its straining action on the wound predisposes to eventration. When the stomach contains heavy fluid, the use of the regular stomach tube becomes necessary. It is the rule in our clinic when lavaging the stomach to look at the wound before and after passing the tube. I have known lavage of the stomach to be immediately followed by death in a desperately ill patient who was constantly regurgitating foul material. This accident is unlikely to occur with the use of the Jutte tube. The stomach is kept empty and clean empty by continuous drainage and clean by injecting a warm soda or saline solution every hour through the tube and immediately aspirating it. This does not in the least disturb the patient, but on the contrary, makes

him feel better. It is a common occurrence to see a patient go to sleep after the Jutte tube has been introduced and the stomach emptied. In our experience, intestinal regurgitation is best handled in this way. We find it much more valuable than either a jejunostomy or an enterostomy as drainage is going on all the time. We have patients who carry the tube for several days, we keep the nares well greased and change the tube from one nostril to the other if necessary. As the patient improves the tube is clamped off for a short time and if he is not comfortable, it is immediately opened, with instant relief. As convalescence becomes established the tube is shut off for longer intervals and when peristalsis is restored nourishment is given through the tube until all nausea has disappeared. The tube is

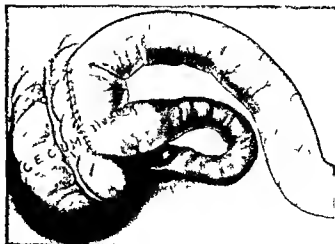


Fig 4b Ileocecostomy

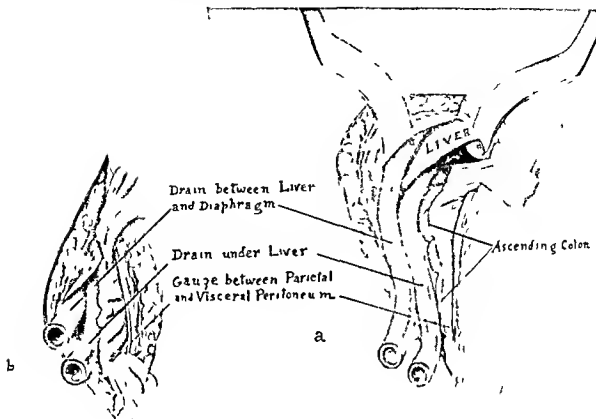


Fig 5 a b and c Drains and gauze in place following appendectomy

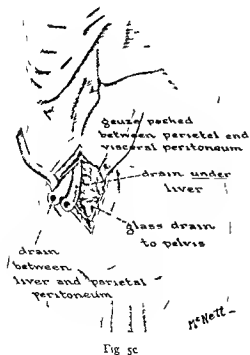


Fig 5c

then removed and nourishment given by mouth. During the time when it is not possible to give nourishment by way of the tube, we employ glucose and normal saline intravenously, protoclisis of glucose, whiskey, and normal saline, and hypodermoclysis. Blood transfusions are occasionally given. In paralytic, but not mechanical obstruction, eserine and strychnine are given at intervals. Pituitrin is rarely used. The circulation is sustained by digalin. Pain is relieved by small doses of morphine, and sleeplessness is overcome by chloral and bromide by rectum. We rarely use the Welch bacillus serum as it has not given us the satisfactory results reported by some.

Whether or not operated upon, a percentage of the fatal crises are not the result of the primary peritoneal infection but of a secondary infection or intestinal obstruction or both, and gangrene of obstructed gut—important factors in the mortality, usually leading to a fatal issue at the time when the patient should be convalescing smoothly.

Acute intestinal obstruction occurring a few days after operation must receive immediate operation if a fatality is to be prevented. To wait for classical symptoms is disastrous.

In passing, I may say that a secondary abscess in close proximity to the wound will often empty through the wound after the use of warm, moist applications. A residual abscess is occasionally found long after convalescence. Pylephlebitis with multiple minute or a large solitary abscess of the liver is very rarely seen.

The causes for the mortality after supposed convalescence, perhaps even while the patient is still in the hospital, or after he has been discharged, are numerous. I will mention only the more common ones, such as secondary abscess, intestinal obstruction, phlebitis, parotitis, and nephritis.

While it is vain to hope that my remarks will have an immediate effect in lowering the operative mortality of appendicitis, I trust I have

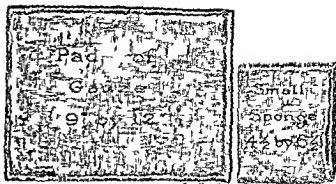


Fig. 6 Gauze used for drainage in appendectomy

indicated the lines along which improvement may be obtained, and that I have impressed you with the fact that appendicitis must be given grave consideration.

## SPINA BIFIDA OCCULTA

### REPORT OF TWO CASES<sup>1</sup>

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SPINA bifida occulta of the lower vertebral arches is capable of producing so many ill-defined symptoms in the areas supplied by the lumbosacral segments of the cord that a general review of the subject seems pertinent, especially since the relevant literature has been so meager during the past 10 years. Our interest in the problem of diagnosis and treatment of these anomalies was stimulated by two unusually illustrative cases, which have recently come under our care and are herein reported.

#### INCIDENCE

The true incidence of this condition cannot be determined from a study of the literature. Cases with a demonstrable defect may present no symptoms, while some with no spinal cleft may present many symptoms. So the first group very likely do not visit a physician and the second group are at times difficult to recognize. Of those coming into the hands of the physician and recognized, only the most interesting cases are reported.

Up until 1910, Brickner was able to collect from the literature only 85 cases of true spina bifida occulta. A relative incidence may be obtained from Woltman's 187 cases of all types of spina bifida. He states that these maladies compose one-sixth of all congenital deformities. Of this series 24 per cent were of the occult type. Con-

sidering the frequency of the lesion from a more reliable angle—that of X-ray examination of a large group of individuals—Wheeler presents some interesting facts. Of one thousand consecutive male adults 2.3 per cent were found to have incomplete closure of the posterior arches of the last lumbar vertebra. They do not mention, however, the first sacral arch which Roederer and Lagrot think is decidedly more frequently involved than any single vertebra. As a whole, considering those cases with and without symptoms, spina bifida occulta occurs more frequently than the literature would indicate.

#### CLASSIFICATION

From an anatomical basis, spina bifida occulta is simply an obscure type of spina bifida. From a clinical standpoint, it may even include a group of cases without demonstrable vertebral defects yet with symptoms identical with spina bifida occulta. To this group Fuchs gives the name of *myelodysplasia*. Upon etiological bases, spina bifida, spina bifida occulta, and *myelodysplasia* may well be grouped together as varying degrees of the same condition.

#### ETIOLOGY

Early in fetal development, mesoblastic tissue normally interposes itself between the skin and

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the underlying neural canal. From this tissue are developed the vertebral arches and the spinous processes. It is not agreed at present as to the factors responsible for the failure of this development. Theories concerning chemical, mechanical, and physiochemical factors have been advanced.

One of the earliest theories was advanced by Morgagni in 1779 (quoted by Woltman). He proposed the interposition of spinal fluid between the lateral mesodermal structures, thus preventing the fusion of the lips of the medullary groove. This hypothesis has been repeatedly advanced and decried by various writers (Patterson, Sharpe). Woltman discredits it entirely, because the secreting mechanism of the cerebrospinal fluid does not elaborate fluid until the tenth week, while it is generally agreed that the spina bifida deformity is produced no later than the third week.

From experimental and clinical observations various factors have been shown to be connected with the development of this lesion (3, 9, 13). No one agent, however, has been demonstrated as the causative factor. At present, at least, it seems best to indorse a conception, broad in its scope, as the one suggested by Woltman. It embraces the idea of the abnormal characteristics of the gametes or mechanical, chemical, or physiochemical factors influencing the embryonic rudiments either before or after differentiation.

#### SYMPTOMATOLOGY

The location of the lesion and the extent of the cord involvement primarily determine the symptomatology. Generally, the findings may be divided into three main groups, the local signs, the neurological manifestations and the accompanying anomalies.

The larger vertebral clefts may be palpated, while the X ray is often necessary to demonstrate the smaller ones. A lipomatous or fibrolipomatous tumor of varying size may be found directly over the bony defect. The association of hypertrichosis with this lesion is not as common as was formerly thought. In fact it may be said to be uncommon. Dimpling in the sacral region occurs in 40 per cent of normal infants but if it persists after the tenth or twelfth year it is suggestive of an underlying spina bifida occulta (2).

Cord involvement occurs in well over 50 per cent of the cases reported (15). Vesical incontinence is the most common sign. DeVries and Francois cite 2 cases of complete retention of the urine. In 22 adults and a like number of children with enuresis, Peritz (15) found 68 and 35 per cent respectively had spina bifida occulta. The

motor manifestations may be in the form of flaccid or spastic paralysis, twitchings or weakness. Ilassin states that only 3 cases of associated spastic paralysis have been reported. Various dissociated proprioceptive and exteroceptive changes are commonly found. Gazzano reports a case with a neuralgic pain, a condition seldom noted. Trophic ulcers are common. Abnormalities of the deep and superficial reflexes are encountered in many cases.

The most common accompanying deformities are clubfoot, hydrocephalus, scoliosis, syndactylism, hydromyelia, hypospadias and cryptorchidism. Defects of the spinal ganglia, medulla, and cerebellum have been recorded.

#### DIAGNOSIS

The establishment of a diagnosis is not difficult if the condition is suspected and thoroughly considered. Any of the above local signs will furnish a valuable clue. Careful differential neurological and X ray examinations will in most cases reveal the true nature of the trouble. Ill defined neurological signs, occurring in the lower extremities, should suggest spina bifida occulta. Certainly, indolent ulcers of the feet, as in the 2 cases herein reported, are significant and call for a thorough investigation of the cord.

To establish the diagnosis after localizing the lesion on a neurological basis roentgenograms are of great value. In cases of myelodysplasia, the diagnosis must be made on the history and findings alone. In most cases, however, a cleft in one or more of the arches will usually be demonstrated by carefully taken roentgenograms (11).

Lipiodol injection has been used for diagnosis (11). Under ordinary circumstances, however, this should not be necessary. In cases presenting symptoms without vertebral defects, it is conceivably of some advantage.

#### TREATMENT

There is a great variety of opinions as to what cases demand operative treatment and when it is best employed (1, 15). It is generally agreed that cases showing slow progression and late appearance of symptoms offer the best results to operative measures. Operation should be performed if possible before any permanent damage has been done, provided an election can be made. However little hope may be entertained for those early cases with acute onset accompanied by hydrocephalus and other gross defects.

The operative procedures may be designed to relieve pressure by removal of a fibrolipomatous tumor or division of a fibrous membrane spanning

the defect. Tension may be relieved by freeing adhesions, or by dividing the filum terminale. Nerve filaments may be freed from adhesions and replaced into canal if herniated. Such cases offer a good prognosis (7). The dura should always be opened and the nerve roots closely examined.

#### CASE REPORTS

**CASE 1.** E. G., white female, aged 20 years, college student, was referred by Dr. I. A. Arnold, of Louisville, Kentucky. Birth and infant history normal. Patient did not walk until 2 years of age, at which time she developed an indolent sore on the right great toe. This lesion slowly progressed for 18 months when the toe was amputated. At the age of 6 years a similar lesion developed on the second toe of the same foot. Six months later roentgenogram showed extensive bone involvement, and a high amputation was performed through the metatarsal bone. Shortly thereafter while in Georgia, the 3 remaining toes became gangrenous. A diagnosis of leprosy was made. Later the parents were informed by a physician in Atlanta, Georgia, that a spinal lesion was present but no advice was given as to operative treatment. By this time eighteen physicians had examined the patient and none before had suggested a cord lesion to the parents. After the gangrene had demarcated, the distal half of the foot was amputated. Six years later, or when the patient was 14 years of age, the remaining part of her foot became gangrenous and was amputated 3 inches above the ankle. Since then, she has worn an artificial limb. She has had no symptoms referable to the bladder or rectum.

At the age of 19 years an ulcer developed on the left foot and was treated at the university at which she was in attendance. Nine months later the lesion had progressed to the point where amputation was recommended and the patient was sent to Louisville for the operation.

When first examined in June, 1928, the following positive findings were elicited: (1) Right lower extremity was amputated three inches above the ankle. (2) No loss of motor power was demonstrated although there was a marked reduction of the Achilles jerk. Other tendon reflexes were normal. (3) Moderate exteroceptive disturbances were noted over the left foot, especially the plantar surface, sensory examination otherwise negative. (4) There was a crater like ulcer involving the anterior, mesial plantar surface of the left foot about 2 centimeters in diameter. No evidence of acute inflammation was present although the whole foot was tender to pressure. (5) Skin temperature of both extremities was normal. Arteries of foot could be palpated readily. No color changes were demonstrable. (6) Roentgenograms revealed a defect of the arches, beginning in the third lumbar and extending through the entire sacrum. (7) Blood chemistry, urinalysis, and blood Wassermann were negative.

Operation was performed June 25, 1928. A large fibro-lipomatous mass was found beneath the fascia. This lipomatous mass was connected by a cord of fibrous tissue which passed between the open vertebral arches and attached firmly to the dura mater. After this attachment was removed, the dura was opened and the adherent nerve roots of the cauda equina were carefully freed from filmy adhesions binding them to the meninges. Several of the roots were firmly adherent and required painstaking dissection before tension was relieved. The wound was closed in layers with black silk.

Convalescence was normal except for a mild cystitis following postoperative catheterizations. Patient was dis-

charged from the hospital on the fourteenth day after operation, free of symptoms. The ulcer was almost healed, the urinary disturbance had subsided, the hypæsthesia over the left foot and ankle was greatly improved.

Since then her father has repeatedly written that the patient is attending school, carrying an unusually heavy university schedule and has not the slightest evidence of motor or sensory disturbances in the lower extremities. There has been no recurrence of the trophic ulcers in spite of the fact that the patient is leading an unusually active strenuous life.

**CASE 2.** I. L., white male laborer, aged 19 years, of German descent, was seen for the first time November 5, 1929. Two years previously he found a needle sticking deeply into his right foot with complete absence of pain. This was his first realization that something was abnormal. Since, he has noticed a diminished sensation in both lower extremities, which become less marked as the knees are approached.

Two months before entrance to the hospital an ulcer developed on the mesial plantar surface of the right foot and progressively became worse. At no time did the patient complain of paresthesia or radiating pains.

Examination showed the following positive factors: (1) A chronic ulcer on the mesial surface of the right foot. (2) Slight talipes equina valgus of the right foot. (3) Exteroceptive and proprioceptive disturbances more in the right lower extremity than in the left and varying from a slight impairment in the upper part of the leg to a complete anesthesia and a complete loss of proprioceptive sensibility of the toes. (4) Slight weakness was noted in the toes of both feet. (5) Sphincters were normal. (6) Tendon reflexes were normal except those of the Achilles which were very sluggish. (7) Roentgenograms revealed an incomplete defect in the arch of the first sacral vertebra. (8) Laboratory findings were all negative.

On January 13, 1929, an operation was performed under local anesthesia. A midline incision was made from the third lumbar to the third sacral spaces. Underlying the fascia, a fibro-lipomatous mass of tissue was exposed. It extended between the fifth lumbar and first sacral arches through the bony defect and was attached to the dura. The laminae of the fifth lumbar and first sacral vertebrae were removed. An incision was made through the dura and some nerve filaments freed from the inner surface of the dura by means of cotton pledgets and scalpel. The fibro-lipomatous mass was then dissected free from the dura. The cauda equina floated in the spinal fluid apparently free from tension. The wound was closed in layers.

Convalescence was uneventful. The ulcer on the right foot healed in 1 week. Exteroceptive sensibility improved decidedly during his stay in the hospital. The proprioceptive improvement was only slight.

On examination 6 weeks later, pain and temperature sensation had further returned yet not completely, while little change was noted in the proprioceptive system. The patient was able to undertake his former duties in a factory.

The first case presents a tragic history of multiple operations with repeated loss of portions of the right lower extremities. During the 18 years that symptoms were in evidence, the true cause of her trouble was not anticipated, although almost a score of physicians had examined her. Response to operative treatment has been very gratifying, which ordinarily is not the case where symptoms appear at an early age.



The second case is a good example of the slowly progressive type, appearing comparatively late. The prognosis in this case should be good. Of course, ultimately the results will depend upon the cause of the lesion, whether there is a congenital absence of certain tracts or whether pressure or tension are the causative factors. From the early postoperative improvement, one should expect the latter possibility to be the case.

#### SUMMARY AND CONCLUSIONS

1. Obscure or dissociated neurological findings in the extremities should suggest spina bifida occulta.

2. Clinically, spina bifida, spina bifida occulta, and myelodysplasia may be considered as varying degrees of the same condition.

3. Many theories concerning the development of spina bifida occulta have been advanced. No single causative factor common to all has been discovered.

4. The location and the extent of the lesion determines the local as well as the neurological findings.

5. Diagnosis can be made by a thorough neurological examination. X-ray examination in most cases is of value in arriving at a diagnosis.

6. Operative treatment offers complete relief of symptoms in many cases. The operation should include the removal of lipomatous masses, dissection of fibrous cords from dura, freeing of adhesions between the nerve roots and meninges,

and in some cases cutting the filum terminale for relief of tension.

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## ANGIOMA OF THE BLADDER

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**A** CAVERNOUS angioma is usually a cutaneous vascular tumor. It may, however, occur in the muscle, about the gums and tongue (the submucous angioma), in the fat back of the eyeball, in the spleen, brain, liver, kidney, or bladder. True angioma of the bladder is rare, while varicosities traversing the base of the bladder are not uncommon findings. In 1893, Albarran collected but 2 cases from the literature and reported but 1 personal observation. In 1905, Watson found but two angiomata in 653 collected cases of tumors of the bladder. In 1920, Thomas had observed one case of angioma in a series of 62 bladder tumors. In 1922, Scholl reported 3 cases studied at the Mayo Clinic, and, in 1926, Katz collected but 10 cases which he considered cavernous angioma and reported 1 personal case. We have found but 1 angioma in a series of 55 cases of primary bladder tumor observed during the past 8 years.

While it is an infrequent tumor, angioma of the bladder is assuming clinical importance. Severe or fatal hemorrhage may occur. Urinary retention with infection has resulted when the tumor encroached upon the vesical orifice, or there may be invasion of the tissues surrounding the bladder through direct extension of the primary growth, and Jungano considered his case, one in which a sarcomatous degeneration had occurred in a primary angioma.

There is a wide variation in the size of the tumor, the behavior of the growth as to its invasion of the surrounding tissues and in the microscopic findings when such are reported. In Caulk's case the tumor is described as a spider-webbed dilatation of blood vessels, a telangiectatic angioma of small size situated just beneath the bladder mucosa. Macalpine reports by illustration a similar finding. In the observations of Katz, Thomas, Blum, Bachrach, Thunin, Bryan, and Albarran, the tumors were stated as being small, but slightly elevated above the vesical mucosa—bluish in color, cavernous, and spongy in character. From Faerber's and Huebner's reports, one draws the conclusion that the tumor is more prominent in the bladder cavity but still cavernous in type. In the case of Lane, the tumor is described as an extensive naevus involving almost the entire bladder wall. The tumor studied by Kidd is distinctly pedunculated, while in the Case 3 of Scholl the growth developed in the base

of the bladder where it presented itself as a bleeding tumor but it had extended into and involved the rectum. This extension with invasion of surrounding tissues was present in 2 other instances. In Scholl's cases 1 and 2, in Judd's case, and in Jungano's case, there was a distinct tumor mass involving the bladder wall and projecting into the bladder cavity. In our case the tumor was sessile, had an uneven surface, bluish black in color, and did not penetrate the bladder musculature or left ureter, although it had displaced the left ureteral orifice medianward (Fig 1).

Katz described a cavernous angioma as "a vascular tumor consisting of a connective tissue framework composed to a great extent of elastic fibers to allow sponge action and which contains large cavernous spaces lined with endothelium." In reporting his case he considered the observations of Broca, Langhans, Albarran, Lane, Berliner, Thunin, Bachrach, Blum, Huebner, and Faerber, as cavernous angioma. In Scholl's Case 1, section of the tissue showed many blood cysts and sacculations with many fine interlacing blood vessels supported by elastic tissue stroma. In Scholl's Case 2, no tissue examination was reported, and Scholl's Case 3 is reported from autopsy as an extensive cavernous angioma. Satti reports his case as a cavernous angioma. Launay states that his tumor consisted of an elastic connective tissue with dilated vessels filled with blood, at places these dilatations constituting caverns filled with clotted blood. Judd's case was diagnosed a papillary angioma from examination of the tissue section. Kidd's tumor consisted of an overgrowth of non striped muscle fibers containing between them abnormally large and numerous vessels. Microscopic examination of the tumor in our case showed it to be a cavernous angioma (Figs 2, 3, and 4).

The cystoscopic findings and the appearance of the growth as viewed through the opened bladder, seemed to indicate that the angioma in our case was intimately attached to the deeper structures of the bladder wall. However, the ease with which it was isolated and removed by blunt dissection from the bladder wall was possible only because of no intimate connection between the tumor and the surrounding structures. The tumor was situated just beneath the bladder mucosa and took its origin from a single vessel in



Fig 1 The origin of the tumor was from the left lateral wall of the prostatic urethra just distal to the vesical orifice. The tumor extended anterior to the left lateral wall and back onto the base of the bladder forcing the ureteral orifice out of its normal position. The irregular surface and the relative size of the bladder tumor is diagrammatically illustrated in this plate.

the urethra just external to the vesical orifice. These findings conformed to Ribbert's observations of angiomas that they grow but their extension is not a spreading of the tumor process to the healthy vessels of the involved area, but by the projection of new vessels which grow out of the tumor. These new vessels seem to have no connection with the normal vessels of the invaded tissue.

The majority of the angiomas are doubtless congenital of slow growth, and follow a benign course. They may, however, involve neighboring structures and Ewing describes one type capable of metastasis, a tumor more cellular than the usual angioma. The tumor may be multiple and occur in different structures and organs of the same individual. Bachrach's patient had a bladder angioma and two large naevi on the right and one on the left thigh, while Marion's case had a vaginal angioma distinct and separate from the bladder tumor. Lane's patient had a naevus on the buttock. In our case there had been removed an angioma from the back of the eyeball. Whether the bladder angioma was a second primary tumor or a metastatic tumor cannot be stated.

Hæmaturia occurred in all the cases of bladder angiomas studied. Other symptoms were those



Fig 2 The mucous membrane is shown at the free edge of the section approaching the normal in character. The deeper structures show dilated blood vessels emerging into the cavernous tissue at the lower portion of the field. X510.

incident to a co-existing cystitis or to the extension of the growth to other structures beyond the bladder wall. The bleeding was intermittent (Launay) or constant (Laeber) and was severe, endangering the patient's life (Langhan), or but slight as in our case. It was recent (having been present but for 2 weeks in Judd's case) or had persisted for over 9 years (Langhan). The co-existing cystitis was slight or it was the predominating symptom (Launay). Bladder incontinence was present in Judd's case while the pedunculated tumor of Kidd's patient caused a retention. Extension of the tumor beyond the bladder gave rise to a palpable mass.

Of the records studied, almost 50 per cent were found in patients under 20 years of age. Two were under 10 and 8 under 20 years. Ten were in males and 11 in females. Eight times the tumor was located about the base of the bladder and trigone, 3 were in the fundus, and the bladder walls were involved 4 times. The tumor in one instance arose from the walls of a diverticulum (Blum). In 11 instances the tumor was small, 6 were noted to be large, and 2 were said to be massive. In 8, or over 30 per cent of the cases, the



Fig 3 The section was made through the cavernous tissue showing the greatly dilated blood vessels filled with free blood cells  $\times 510$

tumor was stated to be purplish in color or resembling naevi. In 4 of the 11 cases found at cystoscopy, a diagnosis of angioma was made. Two were telangiectatic, one was a small pedunculated tumor, while one consisted of small nodules among a field of dilated veins.

When a tumor with a purplish appearance and an uneven, lumpy surface tending to be sessile, is found during cystoscopic examination of an individual with hematuria, an angioma should be suspected. If the patient is under 20 years of age, there is a greater likelihood of its being this type of growth. Other portions of the body should be examined closely for naevi and their presence would strengthen such a diagnosis. The telangiectatic type tumor should not be confused with the varicose veins frequently found about the trigone and base of the bladder in vesical neck obstruction.

The operative procedures as recorded in the reported cases are varied. In Bachrach's case he merely instilled adrenalin into the bladder, stopping the bleeding. Fulguration through the cystoscope was practiced by Caulk, Thomas and by Scholl in the recurrence in his Case 1, and in his Case 2. This method of treatment was successful in all but Scholl's Case 2, which would seem to indicate that it is applicable in the small cavernous and telangiectatic tumors. Katz employed the Paquelin cautery through the

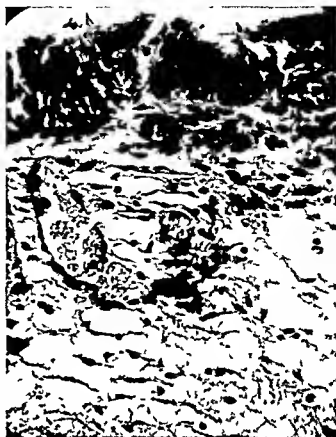


Fig 4 The section was taken from Block A in Figure 3, and we see two of the small superficial rudimentary blood vessels at the surface of the tumor. The morphology of the mucous membrane closely resembles that of the normal  $\times 1530$

suprapubic wound which temporarily stopped the bleeding, but a subsequent recurrence of the hemorrhage ended fatally. In Huebner's case the large nodules were removed by forceps, and the remainder of the tumor was burned by the cautery and the condition cured. Through the suprapubic wound, Bryan destroyed the tumor by means of the serrated scissors when the base of the tumor was thoroughly cauterized and the patient cured. It is thus evident, if cauterization is done, that the tumor must be completely destroyed to expect a lasting cure. In Kidd's case the tumor was removed by severing the pedicle between clamps. In Scholl's Case 1, and in the cases of Marion and Judd, extensive operation with removal of a section of the bladder were done with cure in each instance. In our case it was possible to free the mass from the bladder wall by blunt dissection with ligation of the principal artery as it entered the bladder neck, and the patient was cured. Verhoogan reports that Pousson has successfully removed two angiomas from the bladder. In Lane's case, upon opening the bladder the growth was found to be

too extensive to attempt any method of removal. In Scholl's Case 3 and in Langhan's case death resulted from hemorrhage before any operation was undertaken, and Albarran's patient died under chloroform while being operated upon.

#### CASE REPORT

Mr P. Q. aged 27 years single consulted us because of a history of repeated attacks of urinary bleeding. The patient's maternal grandmother died of malignant disease of the biliary passages. The father and paternal grandmother were paralyzed. Otherwise the family history was negative. The patient had had the usual diseases of childhood without complications. Inuresis had been present until adolescence. When 13 years old there was removed a small superficial tumor from the lower sacral area. When 14 years of age he developed a bulging of the left eyeball. This gradually increased and was painless. When 15 the left eyeball and a cavernous angioma of the fat lying back of it were removed. There was a recurrence of the vascular growth which 2 years later had to be removed and this cured the condition.

When 20 years old hematuria lasting 3 or 4 days occurred. This was painless and he was free of any bladder symptoms. These attacks were repeated two or three times during the following year. They were never severe were of 2 to 4 days duration and usually followed unusual physical effort.

We first saw the patient 1 year after his first hematuria. Physical examination noted the absence of the left eye and a postoperative scar over the lower sacral region. There was no evidence of cardiovascular disease. The blood pressure was 115 systolic and 75 diastolic. Nothing abnormal was found in the chest or abdomen. The external genitalia were normal. He had never had venereal disease. The urinary output was normal in quantity and the urine showed but an occasional pus and blood cell. The blood count and blood chemistry were normal. The phthalein output for 2 hours was 60 per cent. The blood Wassermann was negative.

At cystoscopy a tumor like mass was seen springing from the floor of the vesical orifice on the left side and extending in a fan shape upward and outward on the lateral wall of the bladder and encroaching upon the left ureteral orifice. This tumor appeared hard was nodular not much elevated above the bladder wall surface, and had dark bluish black areas throughout its extent. The left ureteral orifice was forced medianward but the ureteral channel was not obstructed. The remainder of the bladder was normal.

A diagnosis of a probable melanotic sarcoma was made. However during the following year the patient's general health remained good and there was but very slight if any increase in the extent or size of the tumor. High voltage X-ray treatments were given with no appreciable results. We did not think fulguration indicated and we advised opening the bladder and then dealing with the tumor as conditions found might indicate. Subsequently council chosen by the family concurred in this opinion and accordingly 1½ years after we first saw the patient this was done and the tumor 2½ inches long, 1½ inches wide, and ¼ to ½ inch thick was removed by blunt dissection. There was no difficulty encountered until the dissection reached the urethra just external to the vesical sphincter where it was found to be firmly attached by a good sized artery which was ligated and severed. The remainder of the vessels constituting the tumor were not intimately connected with the bladder wall. The growth was a cavernous hemangioma. There has been no recurrence of the bladder tumor.

Four years later he developed a right hydrocele. The epididymis and testicle seemed normal. The hydrocele sac was aspirated but recurred rapidly and in December 1920 it was surgically resected. No cause of the hydrocele was found and the testicle was not removed.

#### CONCLUSIONS

1. Angioma of the bladder is a rare tumor.
2. It is probably most often a slowly growing congenital tumor.
3. It occurs most frequently in children and young adults, almost one half of the reported cases being found during the first and second decades of life.
4. Navi or angiomas of other viscera may coexist in the patient with bladder angioma.
5. Frequently the tumor has a rough surface with bluish black or violet colored areas as viewed through the cystoscope, indicating its vascular structure.
6. Fulguration of the growth is applicable only to the smaller tumors.
7. Surgical removal of the tumor is possible before surrounding structures are invaded. If accomplished a cure can be expected.

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## CYSTITIS EMPHYSEMATOSA

IV REPORT OF THREE ADDITIONAL CASES IN WOMEN<sup>1</sup>

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CYSTITIS emphysematosa is generally regarded as a rare lesion of the urinary bladder of the human being, the very small number of reports in the literature would lead one to think that this is really so. Hueper compiled from the literature reports of eleven cases in human beings, and I have been able to find two more. To this number I have added 8 cases that I have observed (5, 6, 7), and the cases here reported bring the number of cases personally observed to 11. This fact alone indicates that the condition is not so unusual as it has been supposed to be.

Hueper thought, from the cases he found, that the disease developed only in females. The 11 cases he reviewed were thus limited, and he felt justified in calling attention to sex as a possible etiological factor. However, the 2 additional cases that I found by correspondence and in the literature were both in men, and to this number must be added 4 of my published cases (5). Although it would seem that the lesion is more common in women than in men, still it is occasionally found in the latter.

Hueper noted a case in a female dog, and he called attention to the fact that all previously reported cases in animals had also been found in females. Furthermore, all these animals had been killed when in a presumably healthy state, and examined or their flesh dressed by a butcher immediately after death. This would suggest that the condition was not the result of post-mortem change, but that it had been present before death. True, it had not been recognized as existing during life, but the conditions under which death occurred would almost certainly preclude the development of the lesion after the animal had been killed.

All the cases reported as being found in human beings have been accidental post-mortem discoveries, unless the one case described by Lautenschlaeger be given full credence. He claimed that during the 4 days of observation in the hospital, cystitis emphysematosa was diagnosed ante-mortem. There are certain apparent inconsistencies in the report which he gave that would cause one to doubt the establishment of this claim.

The possibility that cystitis emphysematosa exists during life, or that it may be more than a

mere terminal process, is not entertained by urologists, hence it does not figure in the differential diagnosis of elevated lesions of the bladder as viewed through the cystoscope. It is my growing conviction that this condition does exist during life, and that eventually someone will discover and recognize it during routine examination of the bladder.

Cystitis emphysematosa is not to be confused with putrefactive processes or with the invasion of tissues by the organisms of gas gangrene. It is purely a local lesion, limited to the inner layers of the wall of the bladder, and is not a part of a systemic gas producing bacterial infection. In fact its relation to any form of bacterial invasion has not as yet been proved.

The authors of previously published reports have indulged in various speculations as to the etiology and pathogenesis of cystitis emphysematosa, and have freely called to their assistance data that had accumulated regarding such allied, but distinctly different, conditions as colpitus emphysematosa and pneumatosis cystoides of the intestines. It seems highly advisable to separate the discussion from these two conditions, and to consider this as a distinct and independent entity. Accordingly, detailed reports of cases have been presented to facilitate the elimination of the non-essentials by comparison of one with the other. Surgical and medical conditions have materially changed since the appearance of most of these reports, hence, the necessity of considering factors not previously involved. These include the kind of anæsthetic used if an operation had been performed, the intravenous administration of glucose under similar conditions, more refined methods of bacteriological diagnosis, and so forth. This is sufficient justification for more detailed accounts of the clinical examination and course than would otherwise be proper in this report.

## REPORT OF CASES

CASE 9. A woman aged 44 years, registered at The Mayo Clinic, September 26, 1927. She stated that for 4 years she had been unable to chew on the right side, and that there had been numbness of this region followed by deafness of the right ear with tinnitus. She complained of awkwardness in the use of the right arm and leg, blurring of vision, dull frontal headache and spells of vomiting. For the last 2 years there had been diplopia and forgetful

<sup>1</sup>Work done in the Section on Pathologic Anatomy, The Mayo Clinic, Rochester, Minnesota. Submitted for publication March 19, 1930.



Fig. 1. The gross appearance of the bladder in Case 10. Most of the vesicles are intact; some are discrete and others have become confluent. Probes have been placed in the ureteral orifices to indicate the relation of the vesicles to the trigone. The bladder has been everted so that only the lumen shows in the photograph.

ness. There had been some speech defect for more than a year. During the 5 weeks previous to admission there had been pain over the right mastoid region. The only vesical symptoms mentioned were nocturia, graded 1, and a little dysuria and burning which had been present for the 2 months previous to admission. She stated that she had been catheterized for 6 days when she had been in a hospital under treatment for gastric ulcer. Gastro-enterostomy had been performed for duodenal ulcer 16 years before admission and presumably she referred to this experience.

On examination weakness of the right masseter muscle was discovered, as well as impairment of function of the temporal muscle and of the muscles about the eyelid. There was lateral and rotary nystagmus, an ataxic gait, as far as the right side was concerned, and an intention tremor.

October 12, intracapsular enucleation of a right infratentorial acoustic tumor was performed. For several days the postoperative course was uneventful, but later a sore throat and a tonsillar discharge developed. Fifteen days after operation erysipelas of the face appeared associated with a temperature of 104 degrees F. This condition improved during the following 4 days when the temperature again rose to 103 degrees and the respirations to 50 each minute. Rales developed at the bases of both lungs; the pulse rate increased to 150 and the patient became comatose. Solution of glucose 20 per cent was injected intravenously twice after operation. The urine was examined on several occasions, both before and after operation, and nothing abnormal was discovered. Death occurred 22 days after operation.

Examination of the body was performed 3 hours after death; embalming had been done in the meantime. The

principal cause of death was cerebrospinal meningitis following the clinical appearance of erysipelas. There was terminal bronchopneumonia in both lungs. *Cystitis emphysematosa* was also discovered. *Staphylococcus aureus* was cultivated from the brain.

The mucosa of the bladder was rough, mammillated and presented numerous projections obviously vesicles containing gas. These vesicles ranged in size from 1 to 3 millimeters in diameter. Immediately beneath the mucosa and between the vesicles the tissue was dark and hemorrhagic. This change involved the entire bladder with the exception of the anterior portion of the trigone which although hyperemic did not contain vesicles. The area about the ureteral openings was affected and the orifices pointed slightly but were apparently not obstructed. The alteration of the mucosa was most pronounced in the basal and posterior portions. When collapsed the vesicles left a shredded very rough surface. The wall of the bladder was somewhat thickened, the increase affecting mainly the mucosa and the submucosa. Externally, no changes were seen.

The microscopic data are detailed at the end of Case 11 as they were practically identical in all 3 cases.

**CASE 10.** A woman aged 50 years registered August 11, 1913. In 1924 cholecystostomy and appendectomy had been performed with the removal of one gall stone. She had been well until July 1928 when jaundice had appeared and had increased in severity. She had had clay-colored stools. Since the onset there had been four attacks of abdominal pain followed by slight increase in the color of the stools and possibly by slight decrease in the intensity of the jaundice.

The patient was found to be very obese (265 pounds), deeply jaundiced and extremely weak. The blood pressure was recorded as systolic 182 millimeters and diastolic 100 millimeters. The urine contained albumin graded 1, bile 2 and pus 1. The concentration of blood urea was found to be 70 milligrams in each 100 cubic centimeters; the phenolsulphonphthalein elimination 10 per cent; and the serum bilirubin 26.76 milligrams in each 100 cubic centimeters. The van den Bergh reaction was direct. Crystals of leucine or tyrosine were not found in the urine when it was examined on two occasions.

During the 6 days of observation before the patient's death, solution of glucose was given intravenously three times. The carbon dioxide combining power of the blood reached 65.3 volumes per cent. The deep jaundice persisted. The patient became drowsy and then unconscious. She died after having had several severe convulsions. She was catheterized 2 days before her death.

Necropsy was performed 1 hour and 25 minutes after death on the unembalmed body. There was found chronic atrophy of the liver (weight 135 grams), icterus graded 3, acute jaundice, nephritis with uremia (clinical), and cystitis emphysematosa (Fig. 1).

The entire wall of the bladder was covered with petechial hemorrhages more pronounced in the posterior half of the trigone and the adjacent base of the bladder. Small rather diffuse hemorrhagic areas 1 to 2 millimeters in diameter were distributed over the remainder of the wall. Numerous gas-containing vesicles 1 to 3 millimeters in diameter were scattered over the entire area, densely crowded over the bladder proper and an occasional smaller one was seen on the trigone. The surface of the bladder presented a lumpy appearance due to the larger vesicles pushing farther into the lumen. The hemorrhages were for the most part in the interstitial tissues lying between the vesicles. There were no vesicles filled with blood. The thickness of the wall of the bladder was materially increased, but changes were not noted externally.

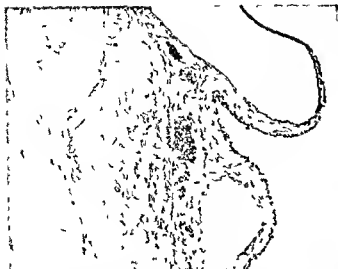


Fig 2 Two vesicles that elevated the surface of the bladder. They are separated by the denser tissues about a group of blood vessels that offered greater resistance to the spread of the gas. A trace of epithelium has been left in the crevice between the vesicles. The lumen of the bladder is shown on the right side.  $\times 65$



Fig 3 The basal portion of the epithelium has been preserved in this section. Parts of two vesicles appear in the deeper portions. The walls display very little inflammatory reaction. Three of the superficial blood vessels contain recently formed thrombi.  $\times 155$

**CASE 17.** A woman aged 54 years, came under observation, July 8, 1929. She stated that for 15 years she had had recurrent attacks of colic in the upper right quadrant of the abdomen at intervals of from 4 months to a year. These attacks had been associated with nausea, vomiting, chills, and jaundice. The pain had radiated along the costal margin to the back. At times morphine had been required to afford relief. The last attack had been 4 days before registration, this one accompanied by fever. The pain had persisted since that time. Urinary frequency had been associated with each attack and had lasted perhaps 2 days. The urine had been very dark and not a large amount had been passed at any one time. Five years before admission she had suffered from thrombophlebitis of the right leg, and she had been confined to bed for a month.

Jaundice at the time of examination was slight. The upper portion of the abdomen was tender. Râles were noted in the base of the right lung. Varicose veins of the right leg were prominent. A diagnosis of empyema of the gall bladder was made, and operation was performed July 15. Four stones were removed from the gall bladder and one from the common bile duct. An irregular fever developed the following day and persisted throughout the postoperative course. The wound became infected, eventually fluid accumulated in the right side of the thorax and drainage for empyema was performed, August 9. Phlebitis and metastatic abscesses appeared in the right leg. The patient gradually failed and died 27 days after registration.

The urine, examined before operation and several times afterward, contained albumin, graded 1, and pus, graded 1. The concentration of urea in the blood was found to be 41 milligrams for each 100 cubic centimeters and the coagulation time, 8 minutes. No note was made on the charts that the catheter was used and no record of any urinary symptoms appeared. Solution of glucose, 20 per cent, was administered on thirteen occasions after operation.

Necropsy was conducted on the embalmed body 6 hours after death. Embalming presumably had been done within 2 hours after death occurred. The principal findings

included empyema, pyelophlebitis with abscesses of the liver, infected thrombosis of the hepatic vein, and of the veins in the right leg, and cystitis emphysematosa.

The inner wall of the bladder, beginning abruptly above the trigone, was elevated by a mass of vesicles of various sizes. In the center of the mass the surface was rough and shaggy. This appearance was caused by the remains of the walls of collapsed vesicles, at the edge of this area, the vesicles were discrete and smooth. Beneath the ragged portion the vesicles were about 1 to 3 millimeters in diameter whereas those at the periphery occasionally reached a diameter of 8 millimeters. The vesicles were clear and contained gas. The involved area had an irregular, reddish mottling, probably due to diffuse but slight hemorrhage in the tissues beneath. The lesion was confined to the base of the bladder, the dome and sides were free from involvement. The wall of the bladder throughout the extent of the lesion was about 1 centimeter in thickness, but was of the usual thickness elsewhere. The external surface of the bladder was apparently normal.

**Microscopic appearance of the vesical walls.** The epithelial lining of the bladder usually was completely lost, although it persisted as traces occasionally in the deeper depressions in the surface between the vesicles (Fig 2). In a few instances it was present as a demonstrable layer (Fig 3) where the wall of the vesicle was thick, or rarely where it was extremely thin (Fig 4).

The subepithelial tissues were usually more or less infiltrated with leucocytes, or with fibroblasts. Hemorrhagic infiltration was commonly seen. These collections of erythrocytes were either small and limited in distribution, or were diffuse and widespread. In such areas the blood vessels were commonly unduly filled with corpuscles and often contained an unusually large number of leucocytes. The blood vessels offered resistance to the extension of the gas in the tissues (Fig 2). Often blood vessels were found bordering the vesicles. The injurious effect of pressure on blood vessels is shown in Figure 5, in which the lumen is almost completely obliterated at the point where it comes to be in immediate contact with a vesicle. The same effect was noted on a lymphatic vessel, as shown in Figure 6. Here the extension of the gas had pro-





Fig 4 A portion of the very attenuated wall of a vesicle to which the basal layer of the epithelium is still attached. The submucosa is reduced to a thin layer of connective tissue in which few nuclei are visible  $\times 175$

duced two vesicles one on either side of the lymphatic vessel leaving the vessel as part of a septum that eventually ruptured. The two ends of the lymphatic vessel can be seen gradually narrowing as they approach the vesicle and then the continuity is lost where it becomes part of the septum. The splintering effect of the extension of the gas in the tissues was sometimes seen. The more resistant elements of the submucosa were found in the incomplete septa that partly separated the vesicles; the softer elements were compressed and readily destroyed. Dissolution was favored in those areas infiltrated with leucocytes and already subjected to injury possibly from bacterial action. Necrosis then had entered largely into the creation of these spaces in which the gas was found. This was not generally true in the deeper portions where as in Figure 7 the well preserved elements were forcibly pushed aside in the production of a honeycombed gas filled area. This extended down to the layers of muscle seen in the lower right hand corner of the photograph.

Mention has been made in previous reports both by me and by others of the occurrence of giant cells in the deeper submucous tissues. These did not occur in the immediate vicinity of the vesicles but a little farther away. They were found in situations in which there was evidence of chronic inflammatory change and were not in demonstrable relation to well formed lymphatic vessels. They are probably cells of the reticulo-endothelial system possibly endothelial cells from tissue spaces that have been so injured that their nuclei have grouped by cohesion into small aggregations. No evidence of mitotic division was seen in any of these cells to account for the apparent multiplication of the nuclei. However there was regional reaction of the tissues to the same stimulus for practically all the giant cells were arranged with their long axis in a common direction. These cells were more common in the deeper layers of tissue just internal to the layers of muscle, than they were closer to the lumen.

Desquamation of epithelium was noted in every case in which examination has been done thus far. It was difficult to assign to this phenomenon any definite significance. Normally the epithelium stretches as the bladder fills, but the distention is uniform, and not localized, as it is in the presence of gas containing vesicles. Furthermore, the epithelium of the bladder desquamates readily when exposed for any considerable period of time to the action of urine. It was assumed that these two factors operating together would account adequately for the loss of epithelium over almost



Fig 5 A blood vessel compressed and in part obliterated by pressure from gas. Its full size is shown in the lower left hand corner of the picture and then its lumen is seen rapidly to narrow as the vessel courses to the right. It is absent where the vessel borders the vesicle. One vesicle is shown below and two vesicles are shown above. Extravasated erythrocytes and a few fibroblasts are found in the tissues  $\times 285$

the entire surface, possibly leaving traces of the cells in the crevices where the epithelium would be more or less protected from both distention and autolysis. The presence of a well defined layer of epithelium in Case 11, as shown in Figures 3 and 4, opens the question once more. Necropsy was performed on the embalmed body 6 hours after death. This permitted the action of urine over a period of time which much exceeded that in several cases studied. Hence, one must conclude that exposure to the action of urine was not so important as previously has been supposed. The one section, taken from this bladder, in which epithelium was found was devoid of definite inflammatory reaction, whereas the other one showed definite evidences of it. In the former the epithelium was fairly well preserved, whereas in the latter it had disappeared. The section from which Figure 4 was taken came from the crest of a vesicle where presumably the tension was greatest, hence mechanical stretching alone had had little influence. We may conclude, therefore, that the presence of inflammation in the form of cystitis is probably the most important factor in removing the epithelium from the surface of the bladder.

If the conclusion that cystitis accompanied each and every case of cystitis emphysematosa thus far personally studied is correct, then it follows that the cystitis must have had a cause, and that it developed as an antemortem and not

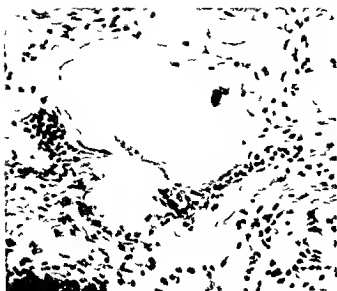


Fig 6 A vesicle has formed around a lymphatic vessel that now bridges the empty space, a portion of the lymphatic vessel is seen on either side of the broken septum. The central part has been compressed and then destroyed by the pressure of the gas. The correctness of this interpretation has been checked by studying adjacent sections. The vessel contains many leucocytes  $\times 165$



Fig 7 Multiple vesicles formed beneath and within the submucosa, the epithelium has completely disappeared. The open space at the top is the lumen of the bladder, and a bit of muscle shows in the lower right corner. The septa between the vesicles are broken and incomplete, permitting free communication between them  $\times 25$

as a postmortem condition. Cystitis is usually produced by the action of bacteria, and the assumption may well be entertained that they are the cause in this condition until the contrary is established. In this connection it should be emphasized that cystitis and cystitis emphysematosa are not synonymous, and that to prove the existence of the former does not establish the concomitant presence of the latter. For the present, at least, it may be well to consider them as separate, and to believe that definite cystitis is present in all cases of cystitis emphysematosa, but to defer judgment as to just when and how the gas forms, or in other words when the condition of cystitis emphysematosa appears.

It is believed that the changes in the tissues are dependent on the cystitis to a large extent, but it remains to be determined which of these changes are peculiar to this special form of disease of the bladder. With this limitation in mind, the various changes will be considered as they were observed, leaving for further work to discriminate which are essential and peculiar to cystitis emphysematosa.

Bacteria have been demonstrated in nearly every case in one way or another. In Case 11 they were abundant in the denuded submucosa, and were combined with lime salts deposited in the superficial tissues. This strongly suggests not only the presence of bacteria in general but of the proteus ammoniae in particular, which Hager and

Magath have described as the cause of encrusted cystitis with alkaline urine. This organism as later described in detail by Magath, and given the name quoted. This organism is regarded as a secondary invader, one that becomes implanted on cystitis produced by some other cause, or in a bladder affected by a tumorous growth. In the present instance its presence, if such it proves to be, may be regarded as of little importance, other than to indicate still further that some form of cystitis already was present.

Evidences of inflammatory change were found in most sections. Leucocytes were abundant in the region about the collections of bacteria and lime salts, and the tissues showed the dissolution dependent on necrosis from this cause. Tissues already softened are rendered more friable, and hence are invaded the more easily by the spread of the gas. Intermediate stages were seen in various other sections. Inflammation was noticeably absent in portions in which the epithelium was still present, and usually scanty in amount in the immediate vicinity of a fresh hemorrhage. Leucocytes were not associated directly with the giant cells, and were not often found deep in the tissues near the muscle fibers. Fibroblasts were found in an inverse ratio to the abundance of leucocytes.

Hemorrhage of more or less intensity was noted in every case. Often it extended beyond the limits of the vesicles, and sometimes it was found in the tissues between them. It has been argued that blood escaping into the tissues carried with it dissolved gases which were lib-

erated when the tension was lowered. Still, emphysema is not associated with hæmorrhages in other parts of the body, nor is it conceivable that the amount of gas found in the vesicles could have been dissolved in such a small quantity of blood. On the other hand, the development of vesicles by splintering the tissues in which they form would have a serious effect on the blood vessels in that vicinity. In Figure 5 are small blood vessels compressed and in places obliterated by the extension of a vesicle against them. Thrombosis was often found, as illustrated by Figure 3.

Even arteries of larger size may be influenced deleteriously. The walls may be too dense for collapse to occur but the development of emphysema all about them might readily induce hæmorrhage or compromise the blood supply to a given part. Stasis usually was found wherever bleeding had taken place, hence one may assume that hæmorrhagic infiltration is a secondary phenomenon. Still the possibility must not be lost sight of that free blood might provide nourishment for special gas producing bacteria that gained entrance to the urinary bladder. This question cannot be answered with certainty until a causative organism has been isolated, and its etiological relationship established.

The lymphatic system seems to suffer in much the same manner as do the blood vascular channels. The common changes in a lymphatic vessel are shown in Figure 6, in which compression precedes obliteration when the pressure of an enlarging vesicle is exerted against it. Evidence that the lymphatics take anything more than a secondary part in the process has not yet been discovered. It is conceivable that gas once formed in one part might spread to another part, along the lymphatic channels. In fact lymphatic vessels distended with gas have been found in previous studies. In such a case the lymphatic vessel would suffer from internal distention rather than from external compression. This manner of spread would help to explain the invasion of tissues that do not as yet show evidence of inflammation from portions in which this change is very marked. Such a condition was discovered in Case 11, and was mentioned when desquamation of epithelium was considered. Even though the lymphatics had been important in the early stages of the lesion, they would be injured by compression whenever the gas escaped into the tissues. In any case the vesicles as they were observed were not merely dilated lymphatics, but were real spaces artificially produced in the softer tissues as the gas spread in those directions offering the least resistance.

The distribution of the gas obviously is subject to certain limitations, that of tissue resistance is the most important. Such a limitation is shown in Figure 2, in which two vesicles were kept separate by the denser tissues about a group of blood vessels. Smaller vessels offer slight but definite resistance, but in the end suffer destruction. The submucosa of the bladder is normally loose and freely movable, a condition of significance in the physiological distention of this organ. It would be natural, then, for gas, once it had been set free, to travel without great hindrance in almost any direction. This it seems to do from a point usually in the base, passing backward, up the sides and to a slight extent forward. In only a few of the cases has there been any appreciable involvement of the trigone, Cases 9 and 10 showed only slight involvement of this area. The mucosa is more tightly adherent to the underlying structures in this portion, hence relatively slight invasion is to be expected.

In a gross way the vesicles seem to be independent one of another. Puncture of one large vesicle does not immediately cause collapse of those nearest to it. This statement is borne out in Figure 1. Collapsed vesicles are to be seen in abundance, and yet the vesicles at some distance are still distended. Possibly this means that the gas originates from multiple foci, or else that it is so well imprisoned in the tissues as not to be able to pass laterally for any considerable distance. The appearance of sections of the tissues, as shown in Figures 2, 5, and 6, would suggest such limitation to a given area. On the other hand, Figure 7 shows that the vesicles intercommunicate. The septa are definitely broken down, and do not represent walls but rather strings of ragged material stretching across from one wall to another. These strings break down readily when they are composed of softer tissues, but persist for a longer time when the connective tissue strands are more resistant.

The most noticeable change in the tissues adjacent to but not actually involved in, the formation of vesicles was the production of giant cells. These were absent in the walls of the vesicles, but appeared in the tissues a little farther away. They were aggregations of nuclei, numbering from two to perhaps seven, although the latter number was exceptional. Three or four were more commonly seen. They were scattered through the tissues where one would expect the presence of slight but definite compression. They have not been shown to be connected with the lymphatic system, but rather with the fixed cells of the reticulo endothelial system. The apparent

increase in nuclei would suggest active multiplication, but mitotic figures have not been seen. Groups of cells of this kind have not been observed in the walls of structures definitely identified as lymphatic vessels. The most common site in which they occurred was in the edge of a bit of cytoplasmic material immediately adjacent to an open streak, believed to represent a tissue space. It was not determined that they formed an actual lining to this space, but rather that they were present in the wall. The nuclei of the giant cells stained a little more deeply than did those which occurred singly. This hyperchromatism appeared to be due to small clumps of chromatin scattered about the nucleus in an irregular manner, and was interpreted as a degenerative phenomenon. Cells with a single nucleus were paler, and the chromatin was distributed in much finer granules. The cytoplasm showed no definite evidence of impending dissolution.

The directional arrangement of the giant cells in a given area was a noticeable feature. In some instances the long axis of practically all of the cells was in the same direction, and parallel to the surface of the mucosa. This corresponds with the direction taken by the tissue spaces, and in general with that taken by the lymphatics. It does not inform us which structure is involved, but rather indicates that the whole region was subjected to the same deleterious influence, probably that of pressure, possibly a low grade of inflammatory change.

#### SUMMARY

Three additional cases of cystitis emphysematosa are reported, with the essential observations, made at necropsy, to provide a basis for further comparison and analysis, thus to detect important etiological factors.

Two of the patients had been subjected to recent operation. There were no special urological symptoms, and cystoscopic procedures had not been carried out. Cystitis emphysematosa was found at necropsy, and its presence was not suspected during life. One patient was reported as having been catheterized, the 2 others may have been. Solution of glucose was administered in-

travenously to all 3. They were all comatose for several days before death occurred.

Cystitis emphysematosa was well marked in all 3 cases. Bacteria were cultivated from one case at necropsy, and the sections disclosed their presence in at least one other. Inflammatory changes were pronounced, including leucocytic infiltration, necrosis, hemorrhage, stasis, and formation of giant cells. Inflammation was chiefly responsible for the desquamation of epithelium rather than the mechanical effect of extreme distention. The vesicles appear to be grossly independent one of another, but microscopically freely intercommunicating and confluent.

There is reason to believe that cystitis emphysematosa develops during life, that it is dependent on inflammatory changes in the wall of the bladder, and that it may be produced by the action of bacteria. It is at least a pathological entity, and may be found to be of real clinical significance if the possibility of its development during life is sufficiently appreciated. The term is a valid one, descriptive so far as the development of gas-containing vesicles is concerned, and etiological in that it recognizes the concomitant appearance of inflammatory changes. The relation between the cystitis and the development of vesicles has not as yet been determined, whether the former is of a specific and distinctive character, or whether it merely provides a favorable soil in which the vesicles develop through the intervention of an entirely independent factor, is still to be determined.

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## TRICHOMONAS VAGINALIS VAGINITIS

A COMMON CAUSE OF LEUCORRHOEA<sup>1</sup>

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**L**EUCORRHOEA is the most common symptom among gynecological patients, and one which often causes considerable annoyance as well as alarm.

In a large group of cases in which the leucorrhœa is of vaginal origin, the condition is very resistant to treatment and repeated smear examinations throw no light on the etiology. In the majority of these cases, the leucorrhœa is due to a vaginitis caused by a flagellate—the trichomonas vaginalis. Donne in 1837 was the first to note this organism in vaginal secretions, and his accurate description of it and of the vaginitis which accompanies its presence has withstood the test of time. Although almost one hundred years have passed since then, practically no additional information has been added. It is unfortunate that many gynecologists in this country have been in ignorance of it, and that some of the European men have considered it a harmless parasite. There is still some controversy as to whether the trichomonas vaginalis is saprophytic or pathogenic, or whether it becomes pathogenic under certain conditions. Recent European writers and all American authors are convinced that it is pathogenic. Our series fully bears out this contention. It remains for the laboratory to answer this question by scientific proof.

All workers are agreed that the organism is found in the vagina frequently, the figures in the statistics ranging from 6 to 50 per cent of all cases examined. The organism has never been found before the onset of menstruation, but it is frequently found during pregnancy and after the menopause. It is infrequently found in the urine of both men and women. Only one case has been reported of a pyelitis and cystitis caused by it, but a few cases of urethritis and prostatitis are reported as caused by it, in 2 of which the reports state that the organism was present in the vagina of the wives. Until recently, the American literature on this subject has been quite meager. Dock, in 1896, was the first to write about it in this country, and he reports only two cases. Lynch in 1915 was the first to culture the organism. Davis has cultured them repeatedly, but a pure culture has not yet been obtained, nor has the mode of infection been demonstrated in a single instance.

I wish to present the clinical report of 78 cases which I have treated or helped treat in the private practices of Dr. F. C. Holden and of my own, in the ratio of two to one. These cases were all detected within the past year. We have not as yet undertaken the study in the dispensary.

The symptoms are so characteristic that the diagnosis can usually be made on the history. The outstanding symptom is an irritating leucorrhœa with a disagreeable odor, frequently accompanied by itching which may be severe enough to disturb the patient's sleep. Dyspareunia is a frequent symptom. Urinary symptoms are relatively infrequent. When one examines a patient who has not been treated recently, there is an acute vulvitis present with a scant foamy discharge between the labia. There may be a dermatitis affecting the inner aspects of the thighs. The vagina is inflamed—the best description being a "strawberry vagina"—and bleeds when sponged. The cervical mucosa is red, frequently there is a cervical erosion of varying size, or there may be an eccentric erosion of the portio away from the external os (Fig. 1). This is the only type of infection in which I have seen this peculiar type of erosion. The vault of the vagina contains varying amounts of the discharge, white or yellow, with minute air bubbles, giving it a foamy appearance. The cervical canal is not affected. Condylomata were seen in 4 cases, Skene's ducts were infected in 2 others.

The clinical diagnosis can be quickly verified by placing a drop of the discharge from the examining gloved finger on a slide, to which one drop of normal saline is added, and by examining the slide under the high dry lens. The picture is typical, a large number of pus cells, few or no epithelial cells, and in every field there will be seen innumerable of these trichomonads. I shall not describe the organism, as it is recognized only by its motion, and one glance at the living organism will convey more than pages of description (Fig. 2). The organism is in constant motion, and when free from debris, can move rapidly. When caught under a group of cells, it will agitate the entire clump in a rapid to and fro oscillating motion. When dead, it becomes round and cannot be differentiated from the pus cells, and is therefore not recognized in the stained smears.

<sup>1</sup>Read before the New York Academy of Medicine, Section of Obstetrics and Gynecology, January 28, 1930.

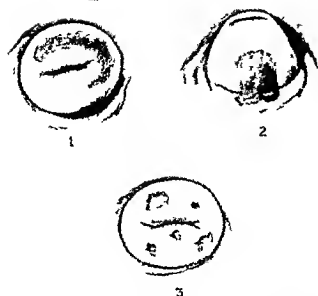


Fig 1 Various types of eccentric cervical erosions seen in trichomonas vaginalis vaginitis. 1, Horse shoe shaped erosion, 2, lesions extending to vaginal vault, this location is commonly affected, 3, multiple superficial scattered lesions, which bleed readily.

unless fixed and stained in a special way. For this reason and because examination of fresh secretion is not done routinely in cases of leucorrhœa, this condition has in the past been frequently overlooked.

The clinical picture may be identical with that of gonorrhœa. The stained smear shows large numbers of pus cells with few other bacteria, and as such a smear is also suspicious of a gonococcus infection, many of these cases have been erroneously diagnosed as gonorrhœa, with all the stigma and mental agony attendant upon such a diagnosis. I feel sure that upon accurate investigation, many of these so called "elusive gonococci cases," i.e., those cases having all the clinical and smear characteristics of a gonococcus vaginal infection in which the gonococci could not be found, will in reality be found to be trichomonas vaginitis. Smears should nevertheless be taken in order to make a careful search for gonococci, for occasionally both infections may be present.

There are many different treatments in vogue, which is a true indication that the specific treatment has not yet been found. This is especially amazing in that the organisms are so quickly killed by any number of germicides. Under the microscope 1 to 2 per cent solutions of mercuriochrome, zonite, pyroligneous acid, methylene blue, and tincture of green soap, all kill the organisms instantly. Drying likewise kills them. It should, therefore, be theoretically possible to cure the



Fig 2 *Trichomonas vaginalis* Donné, as seen in a wet preparation. 1, Two organisms caught by an epithelial cell. 2, organism in a clump of pus cells, 3, pear shaped organism, this is the typical form, 4, slipper shaped organism, often seen in an untreated case, 5, pseudopod formation, which is infrequently seen. The trichomonads are recognized only by their characteristic motion, for when dead, they are indistinguishable from the pus cells.

condition with a single thorough treatment, for Hegner is convinced that there is no cyst stage. Unfortunately this is not the case. Many of the investigators have stated that there is no cure. Others have reported cures after a short period of treatment, only to find that upon continued observation of these cases, organisms and symptoms return after one to two menstrual periods. I do not believe we can arrive at any 100 per cent cure until we learn the mode of infection. The general assumption is that the source is a trichomonad infection of the intestinal tract. This has not been corroborated in a series of investigations made by Hegner both in the human and in monkeys. In our cases, I have not found the organisms in the rectum in any single instance. Lynch found the flagellate in the mouth of his patient as well as in the vagina. In an unpublished case of this type of vaginitis, they were found in the nose as well, causing an acute coryza.

In two of our cases that had gingivitis, we did not find any flagellates in the mouth. Of the married group, the husbands, with one exception, were all symptom free. One husband had dysuria concomitant with his wife's vaginitis, but a thorough urological examination did not disclose any trichomonads in his urethra or prostate.

Our treatment is based on both antiseptics and drying. We at first used a method which Dr Holden has used for years in the treatment of any form of vaginitis. We proceed as follows:

1 Wash the vagina thoroughly with tincture of green soap.

2 Dry and paint with 2 per cent mercurochrome.

3 Pack the vagina full of kaolin, holding the powder in place with a tampon. This is removed by the patient 24 hours later, and the patient uses a tincture of green soap douche and a vaginal powder blower. The douche and powder blower are an excellent method of treatment for the patient to use if she is on vacation or traveling. Although it will not cure her, it will keep her symptom free as long as she keeps up the treatment.

We have tried other treatments but without success. Our present treatment which has given us the best results is as follows:

1 Thorough scrubbing of the vagina with tincture of green soap.

2 Dry, and bathe the vagina with full strength pyroligneous acid. It is important to put the vaginal walls on a stretch, and to turn the speculum all round, in order thoroughly to reach every part of the vaginal mucosa.

3 Pack the vagina with three or more small lamb's wool tampons which are well coated with Lassar's paste.<sup>1</sup> These are left in place until she returns for her next treatment. It is essential that treatments be continued throughout the intervening menstrual periods, as blood apparently gives the organisms their greatest impetus to growth and cures will usually not be obtained unless the patient is treated during the period. During the acute stage, the patient should be seen three times a week, and at this time only 2 per cent mercurochrome should be applied before the Lassar's tampons are inserted. When the mucosa is healed, two treatments a week will be sufficient and should be continued until the mucosa is so thoroughly dry that it resembles skin. This usually takes 6 to 8 weeks. A patient should not be considered cured until she is organism and symptom free for a period of 4 months after all treatment has been discontinued, not even douching being allowed.

It is equally important to take care of the vulvitis, as the organisms are present there. For this purpose patients should wash the vulva and surrounding parts thoroughly twice a day with tincture of green soap, dry the parts, and apply calamine lotion, to which phenol may be added if

itching is a symptom. Sun lamp therapy has been most effective for the dermatitis, if present.

If the patient is a virgin, it is impossible to effect a cure unless the hymen is stretched sufficiently to allow entrance of a speculum. Effective treatment is impossible unless all parts of the vaginal wall can be thoroughly treated. Unless there is some co-existing condition, treatment of the cervical canal is not necessary. In 3 of the cases, where the trichomonads were found during a Huhner test, although the cervix was bathed in a seminal pool swarming with active flagellates, and although the cervical secretion contained many sperms, still not a single trichomonad was found in any of the cervical specimens. Cauterization of the cervical erosions should be delayed until after several weeks of treatment, since most of these erosions heal with the treatment alone. Should a co-existing gonococcal infection be present, the trichomonad infection should be disregarded until the gonorrhoea has been cured.

The results of the powder and pyroligneous acid Lassar's paste treatment are. All symptoms are completely relieved after the first or second treatment. The patients feel as though magic had been used. Organisms disappear usually after the first, always after the second, treatment. The vaginal mucosa is restored to normal appearance in approximately 2 to 3 weeks' treatment. Most cases are cured relatively quickly. A few have not been cured despite prolonged and persistent treatment. Though organisms have not been present for many weeks, and the vaginal mucosa has remained normal for as long as organisms reappear with their ensuing train of symptoms when treatment is discontinued and the patient has had one or two menstrual periods. We believe that it is because the original source of infection is still present in these cases.

Here are a few figures of interest. Please remember that these women were intelligent and of clean personal habits.

The age range was 15 to 65 years, 17 per cent were virgins and 14 per cent had passed the menopause. The duration of symptoms ranged from 1 week to 9 years. Eighty nine per cent had leucorrhoea as their chief complaint, 9 per cent had leucorrhoea as a secondary complaint, 2 per cent had no subjective symptoms, but had clinical evidence of a mild vaginitis. One patient had a concomitant acute gonorrhoeal endocervicitis and salpingitis, 2 patients had had gonorrhoea years before, with apparent cures. Fifty per cent had been under treatment by other physicians without any relief of their symptoms. Of these, 6 had been told they had gonorrhoea, 6 had had

<sup>1</sup> National Formulary.

various operations advised, 2 had operations done, and 1 patient had one vaginal and two abdominal operations, the last being a bilateral salpingo-oophorectomy. Two had been told they had carcinoma of the cervix, which we proved to be eccentric erosions due to the trichomonad.

Of those patients who completed the powder treatment and returned for observation, 70 per cent have remained cured. Of those who had the pyroligneous acid Lassar's paste treatment, 87 per cent have remained cured. These have been symptom free and organism free for a period of from 2 to 10 months, not even simple douching being done.

#### SUMMARY

A common cause of leucorrhœa is a vaginitis caused by the trichomonas vaginalis (Donne). This organism is not recognized in the usual stained smear. The diagnosis is easily made by examination of the fresh vaginal discharge diluted in saline. If the patient has been under treatment recently, examination should be postponed until no douche has been taken for several days or until she has had a menstrual period. In the past year, we have found 78 cases, all in private practice. All of these showed evidence of a vaginitis. The cervical canal, uterus, and adnexa are not affected by this organism. In over one hundred routine examinations of the vaginal secretions of patients with normal vagina, this organism was not found in a single case. We have found this type of vaginitis in virgins after the onset of menstruation, as well as in married women, during pregnancy, and after the menopause. In only one case was there a concomitant gonorrhœal infection discovered. In no instance have we proved the source of infection. One husband had dysuria coincident with his wife's vaginal infection, but the organisms were not found in him. All the other husbands were symptom free. Most of the cases had not been previously diagnosed. Many of them had been treated for years with very little or no relief. Some had been told they had gonorrhœa, 2 had been told they had carcinoma, others had been subjected to surgical measures varying from a curettage to a hysterectomy, without any relief of the leucorrhœa. Our present treatment gives immediate relief of all symptoms, cures the vaginitis in 2 to 3 weeks, and when a patient is carried to this stage, she can remain symptom and

organism free with a daily douche, even if not permanently cured.

To date, we have had a greater percentage of cures than most workers, and we feel that the pyroligneous acid with the Lassar's paste pack is the best form of treatment. We are trying out several simpler methods of treatment at present which we shall report on later.

There is tremendous need for additional information on this type of infection, but at least let us make the correct diagnosis by a routine examination of a wet preparation as well as a smear, in all cases of leucorrhœa, and avoid the terrible mistake of an erroneous diagnosis of gonorrhœa, of carcinoma, or of subjecting the patient to unnecessary operations.

I wish to thank Dr. Holden for his great kindness in allowing me to include his cases in this report and for his many helpful suggestions.

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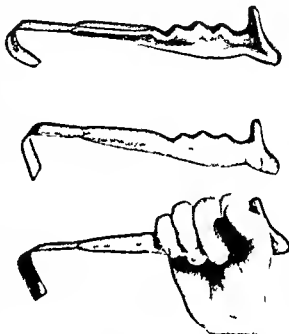
## THORACOPLASTY RETRACTORS

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THE standardization of instruments used in a surgical operation comes when that procedure has been generally accepted, and its technique standardized. Thoracoplasty, most certainly has not been generally accepted and it is with difficulty that one procures instruments necessary for this particular operation. Retractors, for thoracoplasty, vary with the different clinics. In a series of 73 cases done in 1, 2 and 3 stages, over a period of 5 years it was found that retractors play a very important rôle in the technique of this operation, particularly in the resection of the upper seven ribs. Exposure in thoracoplasty is as essential as in any surgical operation. It permits the more rapid and careful removal of larger sections of ribs, with less hemorrhage and subsequent shock. Thus it makes possible a more satisfactory collapse of the lung, the real objective of thoracoplasty.

Retractors must be considered from the standpoint of the patient, the surgeon, and the assistant. There must not be any undue pressure or trauma to the muscles and scapula. The business end of the retractor must adequately expose the field without interfering with the surgeon. The handle end must be such that the assistant can retract efficiently without slipping and changing during the resection of each rib.

The principle of retraction in the resection of the upper ribs is different from that of the lower ribs due to the overlying scapula, where retraction is not only a pull but a lift as well. To prevent trauma in the upper stages it was found that an angled blade was necessary—this angle to fit the vertebral border of the scapula without pressure on the subscapularis muscle. However, this angled blade interfered with the surgical technique in the lower rib resection. For this reason it was found that two pairs of retractors with the suitable angled and curved blades were best for efficient retraction. The same type handle is used on both pairs. This handle was developed step by step after many experiments to give a grip that would not slip from the assistant's hand, that



Three views of the retractor

would not pain his hand during the trying period and cause him to shift, that would permit lifting while retracting, and could be used in either hand.

The accompanying illustrations show the two types of retracting ends, the handle and the manner of gripping for retraction. It will be noted the over all length is less than that of most retractors. This permits the assistant to retract with a steady biceps pull rather than with his body. It thus permits retraction with less trauma. The curved end retractors are used in the resection of the lower ribs and the angled end ones in the resection of the upper. The angled end retractors and handle have been found quite useful in abdominal surgery as well.

THE THERAPY OF PUERPERAL INFECTION<sup>1</sup>

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N EARLY a century has passed since a young Austrian physician, heartsick at the wastage of life which he saw daily about him, consecrated himself to the study of puerperal fever, and finally, with victory behind him, died as a sacrifice to one manifestation of the dread disease for whose conquest he had blazoned the way. I need not rehearse to you the work of that great benefactor of mankind. But I would remind you that the task that Semmelweis set himself has not yet been consummated, I would remind you that puerperal infection still has an incidence estimated as high as 25 or 30 per cent, that it is still responsible for from 30 to 45 per cent of all deaths among parturient women, and that it still accounts for a very large proportion of all gynecological pathology.

These figures are disturbing, but just as disturbing is the evidence recently given that epidemics of puerperal infection in its gravest forms are still possible. Less than 3 years ago, in the Sloane Hospital for Women in New York City, an institution equipped with all the resources of modern science and directed and staffed by some of the ablest obstetricians in the world, roughly 15 per cent of the women delivered over a period of 5 or 6 weeks exhibited a most virulent form of this disease, and roughly a third of this number succumbed to it. I pause here to pay tribute to Dr. Benjamin P. Watson and his co-workers, who, contrary, I fear, to what many of us might have done, gallantly published the report of that nightmare experience, published it in every detail, as a warning of the perils that still beset us and as a protection against similar tragedies.

Puerperal infection is not yet conquered. Possibly in all of its manifestations it never will be conquered. But it can at least be reduced to negligible proportions if general practitioners and specialists alike face the fact that the responsibility for the safe outcome of every delivery rests upon them as individual links in a chain of safeguards which is only as strong as its weakest point. As a clinician and a former professor of obstetrics I lose no opportunity of raising my voice against what I can only term the pernicious teaching of the autogenous theory of puerperal infection. I grant its possibility in the occasional, the very occasional, case. I honor the industry and the brilliant work of the men and women who have devoted themselves to the proof of its

possibility. But I cannot see, except in rare instances, that they have proved their case. The finding of actual pathogenic bacteria in the vaginal secretions of normal pregnant women is only half the proof, and the lesser half at that. The crux of the matter is the exhibition of resulting infections in a sufficiently large number of these same patients to prove that the pathology is due to cause and effect, not to mere coincidence. And up to the present I am not aware that that has been done.

I do not propose to introduce the vexed question of where among the nations of the world the United States stands in its obstetrical achievements. Our exact status is beside the point. You know and I know that our mortality is a disgrace to the nation and to the profession, and I believe with all my heart that it will be promptly and materially increased by loose teaching on the subject of autogenous puerperal infection. Human nature being what it is, a general acceptance of that theory, even for the occasional case, will inevitably lead to a certain carelessness in both teaching and practice in a field in which there is already too much of that particular quality.

Since the therapy of puerperal infection is based entirely upon its pathology, I must devote a few moments to the recollection of certain elementary facts that puerperal infection is essentially a wound infection, identical with the manifestations of wound infection elsewhere in the body, that it includes a multitude of pathological processes, ranging from superficial lesions of the external genitals to peritonitis, pyæmia and septicæmia, that it may be caused by bacteria of every type, though the streptococcus is responsible for the majority of cases and for practically 100 per cent of the fatal cases, that it is potentially graver than the ordinary infection because of the channels for ready extension offered by the lymphatic and venous systems of the pelvis, and because of the fertile field for bacterial growth offered by the traumatized tissues of the birth canal, finally, that it is a possibility in all pregnant women, no matter how normal they may be, because pregnancy is a time of lowered resistance, and that it is a grave possibility in the women whose normally lowered resistance has been further reduced by constitutional and intercurrent diseases, by obstetric complications, chiefly the hæmorrhagic and toxæmic types, by the complications of

<sup>1</sup>Read before the State Sectional Meeting of the American College of Surgeons, San Antonio, Texas, January 20-21, 1930.

delivery, and by operative interference, whether warranted or unwarranted

It follows, then, that the best treatment of puerperal infection is prophylactic treatment. It is easier to prevent it than to cure it. This prophylaxis implies not only the prevention and prompt treatment of purely obstetrical complications, but the elimination of all foci of infection throughout the body, particularly in the genital tract. It implies the full regimen of prenatal care. It implies the preservation of a most rigid aseptic technique throughout the delivery—my own preference is for asepsis rather than antiseptics—with the proper preparation of the vulva, vagina, and rectum, the wearing of rubber gloves and of masks, the elimination or the reduction to a minimum of internal examinations, and the conduct of labor with aseptic expectancy, with interference based on the indications rather than on the patient's demands or the accoucheurs' convenience. It implies a puerperium conducted with regard to the laws of hygiene and cleanliness and with little interference beyond that. Finally, in view of the tragic experience at the Sloane Maternity, it implies the masking of the mouth and nose of all persons associated in any capacity with the patient during her labor and in the first days of her puerperium.

These simple precautions, I believe, are more to be relied upon than the methods of prophylactic immunization reported or being experimented with by Bumm, Lours, Burt White, and others, the practical difficulties in the way of which are very great.

The first consideration in the therapy of puerperal infection is its recognition, and the elevation of the temperature to a certain point, usually set at 100.5, for 2 successive days or for more than 24 hours, is adequate reason for suspecting that the disease is present. Of course, afebrile types of infection must not be disregarded. Lower temperatures are sometimes taken as the criterion, but this is not always fair, even in our zeal we must remember to distinguish between reaction and morbidity.

The treatment in all instances must begin with a general physical examination, to eliminate possible non puerperal conditions, and must be followed by a local examination under aseptic precautions, to determine the pelvic pathology present. Urinalyses and blood counts should be routine. Bacteriological examination of the uterine contents is a matter of such small moment diagnostically as compared with the harm the necessary invasion of the cavity may bring to pass that I do not believe it warranted, and I

am glad to note that Watson shares this view. Repeated blood cultures are made in all cases of suspected systemic infection. The fact that the percentage of positive results is small is counterbalanced by the fact that the clinical course of the disease carries its own diagnosis, but these studies are of prognostic value, too often of tragic prognostic value, as is proved by the fact that in Watson's series death resulted in 6 of the 7 positive cultures. I might add that in these cases the late appearance of the organisms in the blood and the postmortem evidence of lymphatic spread led him to believe that most often the septicæmia was a terminal event, occurring only after the patients were already saturated with toxins.

Local treatment, except for very minor exceptions, is strictly contra indicated. Active intra uterine manipulations are responsible for more deaths than is no treatment at all, for reasons which are quite obvious. In the most virulent infections there are few local manifestations, possibly none at all, so the treatment is unnecessary. In localized conditions it is positively dangerous, in that the spread of infection is by means of bacteria along lymphatic and venous channels, and local manipulations tend to disturb nature's lines of defense and to disseminate the infection. In all types of the disease local treatment is useless, because neither the curette nor the douche can hope to remove the always invisible and usually inaccessible bacteria which are responsible, unless it is undertaken simultaneously with the onset of the infection, a synchronism which is manifestly impossible.

Local treatment, therefore, should be limited to the treatment of superficial lesions on the external genitals by antiseptic or drying powders, and to the removal of protruding debris with the sponge forceps or the gloved finger if the cervix is patulous, if the uterus is soft and flabby, and if free bleeding cannot be checked by a firm vaginal pack, supplemented by doses of ergot and pituitrin. The contracted cervix and the firm uterus are forbidden ground.

Localized pus collections in the cul de sac must be opened by colpotomy, similar collections above Poupert's ligament must be incised and drained, but beyond these procedures surgery has a very limited field in puerperal infection. In the gravest manifestations the disease is beyond the reach of the knife, quite aside from the fact that the surgery which has been proposed is for the most part of so radical a nature that it could never be undertaken as a routine. Hysterectomy, for instance, must sometimes be done, even in the face of infection, for such essential obstetrical indications as

placenta accreta or rupture or perforation of the uterus. If it is done routinely for puerperal infection in the early stages, it will mean, since spontaneous recovery can be expected in most cases, the performance of an appalling number of unnecessary and mutilating operations. If it is not done routinely in the first stages, it will usually be done too late, when the infection has already passed beyond the uterus, when new foci have already formed and the removal of the primary focus is futile, and when the patients are too gravely ill to withstand major surgery. It is small wonder, under the circumstances, that the reported mortality ranges from 50 to 95 per cent, the wonder is rather that any women at all do recover.

Laparotomy for peritonitis, if done in the early stages, may simply serve to spread an infection which might have remained localized in the pelvis. If it is done late, especially if there is an associated septicaemia, it is usually unavailing. On the other hand, drainage under light narcosis is certainly a justifiable procedure in the occasional desperately ill patient, in whom it at least can do no further harm. Laparotomy for tubal involvement has no such argument in its favor. If the gonococcus is the infecting organism, it is unnecessary, as spontaneous recovery is the rule, if the streptococcus is implicated, it serves merely to introduce a new risk.

Ligation of the pelvic veins, chiefly the ovarian or hypogastric, in pyæmia, with the idea of preventing the entrance of detached particles of crumbling thrombi into the blood stream, carries with it, even under the most favorable circumstances, a mortality of something over 30 per cent. Since the mortality in non-surgical cases, however, is from 50 to 70 per cent, it is warranted in that small number of cases in which the diagnosis can be made positively—which is by no means easy—and in which there are no contra indications such as peritonitis or pulmonary, kidney, or cardiac involvement. That it does give occasional brilliant results is proved by a patient I recently saw in consultation on the service of Dr. Hilliard E. Miller. A violent septicaemia, with temperature to 105 and over, and multiple very severe rigors, had existed for 5 weeks, following version done for placenta prævia at term and complicated by an exsanguinating postpartum hæmorrhage. Almost in desperation ligation of both hypogastrics and the left ovarian was done, and the patient made a prompt and brilliant recovery. Such sporadic successes, however, are no warrant for a general employment of this very dangerous operation.

The treatment of puerperal infection by specific agents need not detain us long. All of them have some cures to their credit, but I am skeptical enough to believe that they would have occurred without their use. In the epidemic at the Sloane Maternity, quinine bichloride was used, usually in association with other measures, and some patients recovered, but Watson is prompt to point out that this proves exactly nothing, and his contention is substantiated by the fact that one gravely ill patient in the group, whose physician refused to accept the diagnosis of puerperal infection, recovered also after the administration of some unknown potion called "sun cholera mixture." Most of the series of cases reported for these agents are either too small to prove anything, or else they prove very definitely the danger of introducing foreign agents into the blood stream. Direct slaughter of the offending bacteria is excellent theory but impossible practice, and it cannot be too often stressed that any agent used in sufficient concentration to destroy bacteria stands every chance of destroying first the more sensitive body cells. Moreover, as Martin points out, in the most excellent study of septicaemia of which I have knowledge, bacteria in the blood stream are simply in transit, on their way from one location to another, and their destruction gets us nowhere if the primary and secondary foci of infection continue to pour them out.

Watson's report proves again the uncertain results of serotherapy, even though it proves also that the method apparently does no harm. The case for vaccine therapy is rather different. The results are equally uncertain, but more than one writer has called attention to the actual risk as well as the futility of the promiscuous injection of vaccines, without due regard to the toxæmia of the patient and her capacity for response, knowledge which can be supplied only by a skilled pathologist and the employment of an elaborate laboratory technique.

Aside from the general measures I shall discuss later, blood transfusion is, it seems to me, our main reliance in this grave emergency. Watson is of the same opinion, although the results in the Sloane epidemic, probably because the method was not used consistently, were not particularly striking. It has both a curative and supportive action. Without occasioning the severe systemic reaction which most specific agents do, it improves the anæmia, raises the blood pressure, increases the leucocyte tosis, and generally builds up the resistance. As Stetson points out the hæmolytic streptococcus, above all organisms, produces the greatest hæmolysis and the most rapid blood

destruction, and the wisdom of repairing its ravages is obvious. On the other hand, I should be inclined to be rather wary in following his further recommendation, that, except in the presence of extreme anæmia, the exsanguination method be employed, by which from two thirds to the full amount of the blood to be given is first withdrawn from the patient. I prefer the method advocated originally by Polak, I think, by which from 250 to 300 cubic centimeters of whole blood, with an equal amount of Ringer's solution, is given at three day intervals, or even two day intervals, from different donors. E. L. King, my successor in the chair of obstetrics at Tulane University, has employed this method for some years, and his results, in a ward where the most violent septicæmias are handled, have been very gratifying.

I have had no experience with the method advocated by Hofbauer, that, in addition to transfusion pituitary extract be used in small amounts, to increase the defenses of the reticulo-endothelial system, and to increase the production of the protective mechanism in the parametria, for the identification of which he is responsible. I should be inclined to advocate the therapy, however, the source from which it emanates is its recommendation, and it plainly is devoid of risk.

The immunotransfusion method of Sir Almuth Wright has for its aim the injection into the blood stream of the patient of blood which contains bactericidal plasma and leucocytes produced by the injection into the blood of the donor of staphylococci in huge amounts. This organism is used in all instances because the production of non-specific antibodies is the desideratum. Blood compatibility is of the utmost importance, and in default of a donor from the same group a universal donor must be employed. Four hours after the injection of the donor, when theoretically the bactericidal power is at its height, transfusion is done. The method is impractical for general use at present, but the cures in some instances have been dramatic enough to warrant its earnest consideration.

Aside from transfusion, aside from occasional surgery, aside from the purely local treatment of purely local lesions, aside from the occasional removal of debris from a patulous cervix and bleeding uterus, the treatment of puerperal and post-

abortal infection is limited to symptomatic measures. These patients are hospitalized, in airy, sun-shiny rooms, under the care of competent nurses. They are spared every exertion, including the nursing of their babies. They are given an abundance of nourishing foods, including solids, and they are given fluids by every possible means, including proctocolysis, hypodermoclysis and infusion. Extreme pyrexia is controlled by ice caps, cold sponges and rectal irrigations, seldom by antipyretics and never by baths. Sleep is secured at any cost, and pain is relieved by hot and cold applications and by opiates when necessary. The bowels are kept open by gently given enemata and occasional laxatives. Tympanites is relieved by rectal tubes or by hot stupes. The diarrhœa frequently present aids in ridding the system of toxins, but if it proves too exhausting, it must be controlled by ordinary measures. If vomiting is a distressing feature, gastric lavage should be employed as often as necessary, and the Levin or Rehfsus tube should be left in place for the administration of fluids. Drugs are given only on definite indications, and alcohol has no place in the treatment.

These simple measures, all of them adapted to helping the woman fight her own battle, give more uniformly good results than any surgery, any local manipulations or any specific treatment, for in puerperal infection the patient must create her own immunity, the physician can merely stand by to aid her when she demands help. There is no specific treatment for this disease, and his rôle in it, as Williams aptly puts it, is one of therapeutic nihilism. Every method yields a certain percentage of cures, but one must beware of interpreting a chronological sequence of events as a causative sequence. Some patients will get well, others will die, no matter what we do, but the chances of both groups will be materially improved if we refrain from meddlesome interference. There are many complications of pregnancy in which the advice of Tristram Shandy might well be followed, "Stay thy obstetric hand, return it safe to thy bosom to keep it warm," but none in which it is more applicable than in puerperal infection, whose fearful toll of life and health is increased in direct proportion to the active measures employed in its treatment.

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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OCTOBER, 1930

### CANCER CLINICS

THE discovery of the cause of cancer is being earnestly sought today in well equipped laboratories throughout the world by investigators thoroughly trained in all of the related branches of science. It will be indeed surprising if important additions to our knowledge of the nature of this disease do not result.

In the meantime, however, cancer takes annually a larger and larger toll of our adult population, and that in spite of the facts that have already been discovered, for medical science has already amply demonstrated its ability to obtain lasting cures of cancer by surgery and by radiation, if only this treatment can be applied in the early and local stages of the disease.

Investigations of the cause of cancer must be supported generously and continuously, in the confident expectation that increased knowledge will give us additional measures for the prevention and cure of the disease. Even at the present time, however, much may be done by public education and by the provision of more adequate service for cancer

patients, to make the resources of modern medicine available and effective in the early and curable stages of the disease.

The plan for the organization of cancer services and cancer clinics in general hospitals throughout the country, which is described in the report of the Committee of the American College of Surgeons on the Treatment of Malignant Diseases, which appears in this issue (pages 570-574), marks a definite step forward in providing more adequate service for cancer patients. This project has the support of the directors of the American Society for the Control of Cancer, as well as of the Regents of the American College of Surgeons, and already special clinics of this nature are proving their value in the communities in which they have been already put in operation. A wider development of these clinics, co-ordinated as they will be through the College of Surgeons, can not fail to contribute greatly to the early diagnosis and the adequate treatment of cancer, with the resources now at hand, and thus aid in diminishing the unnecessarily high mortality of this disease.

ROBERT B. GREENOUGH

### THE INCREASING INCIDENCE OF FRACTURES

AS the industrial plants multiply in our country, an increasing number of workers is exposed to injury. Although many "safety-first" methods and precautions have been introduced to lower the incidence of accidents, they never can be completely eliminated, and the human element of carelessness does much to counter-

act these efforts. The rapidly increasing use of machinery in the fields and in the farm-yard likewise has exposed an ever increasing number of agricultural workers to hazards. The automobile is responsible for more than 35,000 deaths annually in the United States, and many times that number are injured. Many of these injuries are fractures, and it has been estimated that our population sustains, from all causes, in the neighborhood of 500,000 fractures each year.

Twenty five years ago interest in the treatment of fractures was probably at its lowest ebb, owing to the fact that the results obtained in abdominal surgery, following the full development of aseptic methods, so overshadowed all other branches of surgery that the hospitals were filled with patients for abdominal operations. There were too few beds available for patients with fractures, and they were treated chiefly as outpatients. Now that these then considered brilliant and unusual results in abdominal surgery are today regarded as usual, the profession is taking increased interest in the ordinary conditions, and fractures, with their many interesting mechanical and physiological problems, are coming into their day.

The country wide building of new hospitals and the enlarging of the older institutions has provided a great number of beds, and this has led to the establishment of wards with excellent facilities for treating fractures in many of the larger hospitals. The lesson learned in the War, that fractures are best handled *en masse* with a trained personnel, is slowly bearing fruit. It is not only in the large hospitals in the large centers that the problem of fractures is a live one, but smaller hospitals in rural communities have been called on to take care of an increasing number of fractures, many of them of a severe and complicated nature.

The American Medical Association sensed this increased interest in fractures, and several years ago appointed a fracture committee. This group has had, at the yearly meetings of the Association, practical demonstrations of the care of fractures, and the demonstrations have been well attended. The American College of Surgeons also has a well organized committee on fractures, and this committee is also actively concerned in promulgating and stimulating an interest in fractures, and in doing all in its power to improve their treatment.

Undergraduate curricula are necessarily limited, and with the great mass of new facts and lessons to be learned that have accumulated in medicine, educators have been in a dilemma as to how much they should require of the student. It has been necessary to cut down the time allotted to the various branches, and that set aside for the study of fractures and their treatment has suffered along with others. The committee on fractures of the American College of Surgeons is calling attention to the necessity of spending those few hours to the best advantage. It urges that a well planned and comprehensive program of teaching the mechanical and physiological principles of treatment that may be applied more or less to all fractures, be established. The details of the diagnostic and pathological aspects, and the treatment of the different types of fractures are well outlined in many of the standard textbooks.

The numerous lawsuits that occur drive home the fact that in no other class of surgery is it more necessary to call for competent consultation in severe or unusual cases. Bad results, due to shortening of legs, limitation of motion of joints, and so forth, stand as a lasting discredit to surgery, and the laity are not slow to take note of them. Roentgenograms or fluoroscopic examination, as a check

on the course of treatment, should be freely used. Constant supervision of apparatus and careful attention to all the many details of treatment are necessary. The care of fractures is a real responsibility.

There can be no hard and fast rule as to whether the closed or the open method of treatment should be used. Some surgeons will use the open method, others, the closed, and this will vary for the same type of fracture. Dr. Charles L. Scudder, of Boston, chairman of the committee on fractures of the American College of Surgeons, in one of his addresses, said that the method used for any given fracture should be the one that would give the best result. This is certainly a ground on which all may stand, but it does not take much imagination to realize the arguments and qualifications that may start from that base. For the same fracture, the method will often vary with the experience of the surgeon, with his equipment and surroundings, and with the patient.

MELVIN S. HENDERSON

## SURGERY, RADIUM, OR A COMBINATION OF BOTH IN THE TREATMENT OF CANCER

THE studies of Forssell<sup>1</sup> based on a large series of cases and followed up for 15 years gives valuable help in the selection of cases for treatment. He reports 102 superficial cancers of the face, all of which were examined at least twice, in 1918 and 1923, at least 5 years following the final treatment. Of the 102 cases given the entire treatment, the percentage of cure was 95 while of 105 infiltrating tumors only 51 per cent were cured. It was found that the percentage of cure was about the same for all age periods, as regards the superficial tumors, but became less with increased age with the infiltrating

tumors. Comparing cases operated upon with those treated by radium it was found that the prognosis of postoperative recurrence with infiltrating cases was highly unfavorable. On the other hand, none of the infiltrating cancers of the lip with inoperable glandular metastasis was healed through radiotherapy alone. Hence, Forssell advocates the operative removal of regional metastasis at the time such patients appear for treatment, and believes that the combination of operative and radium treatment gives the best results. He does not consider excision of the glands necessary in the absence of clinical demonstrable metastasis. He quotes the paper of Nystrom read before the Swedish Cancer Society, Stockholm, 1922, which covers a study of 10,000 cases of cancer followed from 5 to 7 years. This material includes 241 cases of lip cancer which he states also plainly show the superiority of surgical or combined surgical and radiation treatment with regional glandular metastasis. None of the lip cases with metastasis was lastingly healed by radium therapy alone.

The results as concerns cancer of the mouth are based on a paper by Berven,<sup>2</sup> who reported 244 cases, some treated by radiotherapy alone, others by surgery and radiotherapy combined. A tabulation of results shows that 31 per cent of cases without glandular metastasis treated by radium alone remained free from symptoms 5 years or more while 65 per cent remained well following surgery and radium, with metastasis none remained well with radium treatment alone, but 60 per cent treated by the combined method were symptom free.

In operable cases of cancer of the tongue he states that radiotherapy alone gave 60 per cent healing over a five year period while combined therapy gave exactly the same per-

<sup>1</sup>Acta Radiol. 1928 Sup. 11

<sup>2</sup>Acta Radiol. 1927 vol. VII



centage With metastasizing cancer of the tongue, however, radiotherapy alone did not give a single cure He believes that the results of combined therapy are decidedly superior to surgery alone in cancer of the mouth also that there can be no doubt as to the extent which combined healing has increased the duration of cure

The substitution of electrocoagulation for excision was used in too few cases to make any statement as regards its value as compared with excision In cancer affecting the lower jaw he is skeptical about obtaining lasting healing by radiological treatment alone cancer of the cheek, however, has remained healed without symptoms for 5 years and in a few cases for 10 years

In cancer of the cervix uteri he states that the results are in every way equal to the permanency of healing obtained by surgery The results of radium treatment in cases that are operable are twice as good as in inoperable cases this is of course, as would be expected He believes that with cancer of the body of the uterus surgery seems to yield superior results over radiological treatment However, there are a considerable number of patients in whom operation is technically possible but they are in such poor general condition that surgical intervention seems contra indicated, and in these healing by the use of radium alone is frequently satisfactory For cancer of the body of the uterus the percentages of cure given is 47.5 per cent for radium alone and 58.8 per cent for operation

Forssell states that he treats all cases of carcinoma of the breast by surgery whenever possible, but often surgery and radiotherapy are combined All carcinomata of the digestive tract amenable to surgical intervention are also operated upon A total number of 543 sarcomata were treated by radium

or X-ray between 1910 and 1922 Exactly one-third were found free from the symptoms when re examined in 1925 These patients were divided into three groups the first group, 238, were primary tumors, while 154 were recurrences following operation Of 238 primary tumors, at least 148 were inoperable and of all the patients with primary tumors only 24 per cent remained free from symptoms At least 31 more, however, belonged to the inoperable class Of the recurrent cases only 28 of the total of 154, about 18 per cent, were free from symptoms Forssell places the radiological healing of sarcoma at about 30 per cent In the second group of cases in which surgery and radiological treatment were combined the results were surprisingly good Of 151 cases 95 were free from symptoms at the time his report was made The treatment in these cases consisted in radical operation followed, and in several cases preceded, by deep X ray and radium treatment of the tumor and neighboring lymph gland areas Existing statistics concerning results of exclusively surgical treatment show a noticeably smaller percentage of healing He quotes Kuettner, who reported more than 550 cases with only 30 per cent of healing after 5 years' observation

Careful study giving the personal experience and the results of statistical study of others would seem of great value in selecting the form of treatment likely to give most satisfactory permanent results in the management of this difficult form of disease Those who have visited the Swedish Clinics must have been impressed by the earnestness and honest purpose so evident there as well as by their progressive spirit This sense of reliability adds much to the value which one attaches to his estimate of any published work

MARTIN B. TINKER





JOHN M LLDER  
1858-1922

# MASTER SURGEONS OF AMERICA

## JOHN MUNRO ELDER

COLONEL JOHN MUNRO ELDER, C M G, B A, :  
Montreal February 5, 1922, after a lingering illness in  
and much physical disability. In his death the Can-  
an honored member who throughout his life served his fel-  
country with zeal, energy, and marked ability.

Born in the town of Huntingdon, in the Province of  
received his early education in the high school of his own town  
the Faculty of Arts in McGill University, from which he  
tinction in 1881. The following year was spent in acting  
Huntingdon Academy. He entered the Faculty of Medicine  
notable not only as a student but as an athlete, he graduated  
the year of the Riel Rebellion in the district of the Saskat-  
after graduation he accepted the appointment of surgeon to  
son Artillery and accompanied that regiment in its exp-  
rebellion.

On his return he commenced practice in his native town  
into the city of Montreal. He had not been long in the  
offered a position in the Department of Anatomy in McGill  
steadily rose and in 1894 succeeded Dr. Birkett in the posi-  
strator. In 1896 he was appointed as lecturer in anatomy,  
surgical applied anatomy. In the following year he was ele-  
geon to the Montreal General Hospital, and was given the po-  
strator in surgery by Professor F. J. Shepherd who had  
abilities. In 1898 on the death of Dr. Kirkpatrick he was  
of the hospital to fill the vacancy and thus became full  
and an assistant professor in the chair of surgery.

In both the hospital and the college he showed him-  
of no mean ability. His lectures were greatly appreciated,  
there was always a full attendance, both at his demon-  
and at his class lectures in the University. He was a  
for he was not only a good athlete himself, but took  
athletic activities.

Throughout his life Colonel Elder maintained his military interest. On his return from the North West he continued his connection with the Montreal Garrison Artillery for many years, and on retiring was promoted to the rank of surgeon lieutenant colonel. When the Great War broke out and the formation of No. 3 Canadian General Hospital was under consideration, Colonel Elder was the first to volunteer his services and was appointed officer in charge of the surgical division with the rank of lieutenant colonel. The selection of officers for that division was largely his own, and the wisdom shown by him in its organization was fully proved by the excellent work done by all its members. At the front in the actual surgical work of the hospital he took a most active part, and during a battle period when the work was heavy, he was frequently occupied in the operating room from early morning until a late hour at night. At one of these periods of strain while operating upon a suppurating gunshot wound of the thigh he received a severe infection of the right forefinger, which was followed by serious illness and a protracted convalescence.

In November, 1917, on the retirement owing to illness of the Commanding Officer General Birkett, Doctor Elder was promoted to colonel and appointed his successor, and continued as such until February, 1918, when he received the appointment of consultant to the British Army with headquarters at Rouen.

In his service overseas Colonel Elder's exceptional surgical skill and valuable organizing power brought him "mention in despatches" by Field Marshal Sir Douglas Haig. Later on in further recognition of his services he was created a Companion of the Order of St. Michael and St. George.

Colonel Elder during his long service both in the Montreal General Hospital and as commanding officer in charge of the surgical division of No. 3 Canadian General Hospital, was highly esteemed by his colleagues and greatly beloved by his patients. He was an able diagnostician and his long training in anatomy gave him confidence and dexterity in his work. He kept well abreast of the times and made many contributions to the literature of surgery. His untimely removal was deeply mourned by all his confreres, and by all who had the pleasure of working under him.

A. T. BAZIN



DOMINI  
PETRI FORESTI  
ALCMARIANI.  
MEDICINÆ DOCTORIS

EXPERIENTISSIMI, ENCLYTÆ REIPVÆ.

*Delphensis Medico-Physici ordinarij.*

OBSERVATIONVM ET CVRATIONVM  
MEDICINALIVM AC CHIRVRGICARVM  
OPERA OMNIA QVATVOR TOMIS DIGESTA

IN QVIBVS

OMNIVM ET SINGVLARVM AFFECTIONVM  
*corporis humani causas, signa, prognosim & curationem præcipuè de præsentant.*

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*Internorum, externorum ac Rerum mirabilium INDICE completissimè.*

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## OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D., F.A.C.S., OMAHA

### THE SURGERY OF PIETER VAN FOREEST

WITH the crusades the interest in, and development of, medicine and surgery, were reborn on the continent of Europe and one by one the various countries, beginning with Italy and France, developed universities in which medicine was taught, anatomy was developed and from it surgery arose, until by the fifteenth and early sixteenth centuries medicine and surgery were spread over the continent and many countries were furnishing well known and well thought of men to the healing art. One country, however, seemed to let all this progress pass by. Holland, now a progressive country, appeared then to be oblivious to what was going on around her and save for Jean de St. Armand, who flourished in the thirteenth century, furnished no medical men worthy of note until the sixteenth century was well along.

The reason for this must be sought in the economic and political condition of the country. The provinces of the Netherlands during the fourteenth and fifteenth centuries were subject first to the House of Burgundy and later to the House of Hapsburg until in the sixteenth century they became subject to Spain. The provinces especially the northern ones, joined in the Reformation and this protestant uprising Philip II of Spain endeavored to subdue by force of arms. The Netherlands thus had had no autonomy and had been neglected so far as its advancement along cultural lines was concerned, by its foreign rulers. Consequently the medical men had to be educated in other countries and those worthy of promise found the opportunities so much greater elsewhere that they remained away from their native land and their success if any accrued, was accredited to the country of their choice.

Under the championship of William of Orange conditions began to improve somewhat. The revolt against Spanish domination succeeded and Holland began to assume some autonomy. In addition to the houses of refuge for lepers a University for the teaching of medicine was founded at Leyden in 1575 and the Netherlands took its place as one of the progressive countries in learning on the Continent of Europe.

One of the most prominent of the Dutch physicians of the sixteenth century was Pieter Van Foreest or Petrus Forestus who has been given the name of the "Dutch Hippocrates." He was born at

Alkmaar, a little town north of Amsterdam, in 1522 and being the scion of a medical family his duty apparently was to join the same profession. His first studies were undertaken at Louvain and having finished there he began to travel to other Universities in Ferrara, Venice, Padua, and Bologna where he received his doctorate. Not yet satisfied he went to Rome and Paris to find what he could there. Apparently he did not neglect his opportunities for he became friendly with the great men in medicine. In Padua he knew Vesalius and in Paris he worked with Guido Guidi and Jacobus Sylvius. This travel and study occupied him until 1546 when he made his decision to return to Alkmaar and enter into practice. His reputation and practice grew rapidly and in 1557 he was called to Delft as city physician. About this time he began to collect his "observations" and put them down, with the idea of future publication, which was carried to fruition in 1589 when the first volume of two books appeared. Then they followed rapidly until by 1597, the year of his death, twenty-seven books of *Observationum et curationum medicinalium* had appeared to be followed by five posthumous books, making a collection of thirty-two in all. His first publication in 1583 had nothing to do with his observations but dealt with the examination of urine. After his death his works were published frequently as the so called *Opera Omnia* and the publication of 1653 comprises four large folio volumes.

Van Foreest wrote the usual medicine of his day. He was evidently well schooled, knew the ancient languages and literature, and, though not remarkable for anything new, his work is an excellent representation of clear and careful observation, well expressed in understandable terms.

The interesting point about Van Foreest, if one can draw conclusions from actions and so judge character, is his conservatism. A friend of the great men in foreign lands and with opportunities there to do much, he nevertheless determined to go home to Alkmaar and practise. Later in 1575 when the University at Leyden was founded he was asked to become its professor of medicine. He went so far as to go to the opening and make an address but could not see his way clear to accept the professorship. The university was more or less of a chance—Delft was sure. So he went back to Delft to live and practice for thirty-eight years and then went home to his birthplace where he died in 1597.



## REVIEWS OF NEW BOOKS

OF much longer wave length than ultraviolet radiation and yet much shorter than the softest X rays, the Grenz or borderline rays constitute an important field for special investigation and probable value in clinical medicine and surgery. Doctor Bucky's book<sup>1</sup> is a commendable exposition of the evolution of superficial roentgen therapy out of which grew the search for, and the discovery of the Grenz rays, the name selected by Bucky for this particular range of radiation. The zone in question verges on the border of the utilizable and clinically employed roentgen wave length.

The section on the physical foundations of Grenz ray therapy is written by Prof. O. Glasser of Cleveland, a former collaborator of the author. Naturally, radiation of such feeble penetrating power finds its greatest and most obvious useful field of application in diseases of the skin. Technique, clinical symptoms associated with the treatment and dangers are all discussed as well as some applications of this new ray in internal diseases such as arthritis, asthma, pertussis and persistent thymus. Exophthalmic goiter and Hodgkin's disease are recognized as contra-indications.

The introduction of these new rays into therapy has caused considerable more or less acrimonious discussion, but it is the opinion of your reviewer that certain definite helpful indications will result as time and experience bring better judgment.

JAMES T. CASE

THE book *Gall Bladder Disease* is offered by Berlin as a practical aid to those in need of a working basis for the roentgen diagnosis of gall bladder disease. The work consists of a brief chapter on embryology and anatomy, some remarks on the function of the gall bladder and a few brief paragraphs regarding pathology of the gall bladder and associated organs. Then follows a description of the technique of cholecystography by the oral method, which the author prefers and considers very reliable. A large collection of well reproduced roentgenograms of the gall bladder region in connection with cholecystography and its differential diagnosis is given.

Of great interest, because of its rarity, is one case reported of left-sided cholelithiasis with complete transposition of the viscera. To the reviewer's knowledge this is the first time such a diagnosis has been made since shortly after 1900, when the late Carl Beck, of New York, made such a roentgen finding. His case was proved by operation.

<sup>1</sup> *Grenz Ray Therapy*. By Gustav Bucky, M.D. With contributions by Dr. Otto Glasser and Dr. Olga Bucher-Mannheimer. Translated by Walter James Buchanan, M.D. New York: The Macmillan Company, 1929.

<sup>2</sup> *Gall Bladder Disease: Roentgen Interpretation and Diagnosis*. By David S. Berlin, B.S., M.D. St. Paul and Minneapolis: Bruce Publishing Company, 1929.

Most of the cases reported by the author have been proved by operation, so that the book supplies a valuable atlas of proved cases which should be extremely useful for reference purposes.

JAMES T. CASE

IN the second revised edition of his book *\*Otolaryngology* has added a very valuable chapter on laboratory aids to otological diagnosis and a final chapter which covers clinical cases illustrating points in the text. A material aid in associating pathological findings with clinical history.

Basing his classification of ear diseases on pathology, he gives the following: (1) catarrhs (produced mechanically), (2) inflammations (bacterial origin) and (3) general conditions. By general conditions is meant that group of constitutional cases which may present local manifestations. These include acoustic neuritis and otosclerosis. This chapter on the various clinical types of mastoiditis is especially well written and the operative findings in case histories are presented at the same time. Photomicrographs accompany each pathological type, and a great many of the cases have been served prior to operation.

Dr. Kopetzky does not believe in the primary blood clot closure for mastoid wounds but prefers secondary closure some days later, after the tympanum is dry and the posterior wound is begun to granulate.

The text does not carry a detailed account of functional testing of the labyrinth although it is taken up in a general way. The differential diagnosis of labyrinthine disease is discussed fully, although the author states that it is impossible to distinguish between a purulent labyrinthitis, the diagnosis should be made on the clinical history.

A good bibliography accompanies each chapter.

As the name implies the text is devoted to otology and surgery and the author has purposely left out methods of examination and treatment other than surgical. The book is a ready reference for surgical procedures on the ear and contains a great deal more on pathology than is ordinarily found in a textbook of otology.

JOHN F. DELMONTE

FORTY FOUR years after its first appearance, *Elements of Surgical Diagnosis* by Sir Alfred Pearce Gould<sup>1</sup> appears in its seventh edition revised by Eric Pearce Gould. The author stresses the point that with the exception of the diagnostic use of X rays the progress of Surgery since this book was first published has done little to provide short cuts.

<sup>1</sup>*Otolaryngology*. By Samuel J. Kopetzky, M.D., F.A.C.S. St. Paul, New York: Paul B. Hoeber, 1929.

*Elements of Surgical Diagnosis*. By Sir Alfred Pearce Gould, F.R.C.S. (Ed.), F.R.C.S. (Eng.). 7th ed. rev. By Eric Pearce Gould, M.D., M.Ch. (Oxon.), F.R.C.S. (Eng.). New York: Paul B. Hoeber, 1929.

to the diagnosis of surgical affections, and that accuracy and confidence in diagnosis are still to be attained only by methodical and complete examination. Because of this viewpoint the method of handling the subject matter resembles in its thoroughness our best texts in the field of internal medicine rather than those in surgery. The subject matter is treated in an authoritative fashion disclosing author's

intimate workable knowledge of the subject at hand. The excellence and directness of the style deserves particular attention in an era when quantity rather than quality prevails. While not as extensive as monographic treatises, this volume just because of its compactness commends itself particularly to the student, the interne, and the general practitioner.

GEORGE HALPERIN

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**MEDICAL AND SURGICAL YEAR BOOK, PHYSICIAN'S HOSPITAL OF PLATTSBURGH** Vol. 1, 1929 Plattsburgh, New York The William H. Miner Foundation, 1930

**ANNUAL REPORT OF THE REPORTS OF THE COUNCIL ON PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION FOR 1929 WITH THE COMMENTS THAT HAVE APPEARED IN THE JOURNAL** Chicago American Medical Association, 1930

**HANDBOOK OF THE VACCINE TREATMENT OF CHRONIC RHEUMATIC DISEASES** By H. Warren Crowe, D.M., B.Ch. (Oxon.) M.R.C.B., I.R.C.P. New York and London Oxford University Press, 1930

**PHYSIOLOGIE PATHOLOGIQUE CHIRURGICALE, INFLAMMATIONS EFFECT DES TRAUMATISMES RÉPARATION DES PLAIES GREFFES MALADIES DES OS, DES ARTICULATIONS, DES VAISSEAUX ET DES NERFS** By R. Leriche and A. Polliard. Paris Masson et Cie, 1930

**DIE WECHSELBEZIEHUNGEN ZWISCHEN DER TUBERKULOSEERKRANKUNG UND DER GENERATIONSVERÄNDERUNGEN IM WEIBLICHEN ORGANISMUS** By Dr. Joachim Granzow. Berlin S. Karger, 1930

**MANUAL OF PHYSIOLOGY, FOR STUDENTS AND PRACTITIONERS** By H. Willoughby Lyle, M.D., B.S. (Lond.) F.R.C.S. (Eng.) and David de Souza, M.D., D.Sc. (Lond.) F.R.C.P. (Lond.) 3d ed. New York and London Oxford University Press, 1930

**DOCTOR AND PATIENT. THE RELATIONSHIP OF THE PHYSICIAN TO MEN AND INSTITUTIONS** By Francis Weld Peabody, M.D. New York The Macmillan Company, 1930

**ELEMENTS OF PSYCHOLOGY FOR NURSES** By Rev. James Francis Barrett. Introduction by Dr. James J. Walsh. Milwaukee Wisconsin The Bruce Publishing Company, 1930

**LA PRATIQUE CHIRURGICALE ILLUSTREE** Fasc. XVI By Victor Pauchet. Paris G. Doin et Cie, 1930

**CINEMATIZZAZIONE, PRIMO TRENTA ANNI DELLA TEORIA VANGHETTIANA** By A. Pellegrini. Bologna Cappelli, 1930

**CONCENTRIC CLUB FOOT (TALIPES EQUINOVARUS)** By E. P. Brodman, M.Chir. F.R.C.S. New York William Wood and Company, 1930

**CHRONIC NASAL SINUSITIS** By Patrick Watson Williams. New York William Wood and Company, 1930

**HANDBUCH DER UROLOGIE** Edited by A. v. Lichtenberg, F. Volcker, H. Wildholz. Vol. 1. Spezielle Urologie III. Berlin Julius Springer, 1928

**BURNS TYPES PATHOLOGY, AND MANAGEMENT** By George T. Pick, B.S., M.D. and A. Hobson Davis, B.S., M.D. Philadelphia and London J. B. Lippincott Company, 1930

**THE BEHAVIOR OF THE NEWBORN INFANT** By Karl Chapman Pratt, Ph.D., Amalie Kraushaar Nelson, Ph.D.,

Kuo Hua Sun, Ph.D. Supervised by Albert Paul Weiss, Ph.D., and Andrews Rogers, M.D. Columbus, Ohio The Ohio State University Press, 1930

**BIOLOGIA Y PATOLOGÍA DE LA MUJER, TRATADO DE OBSTETRICIA Y GINECOLOGÍA** By Josef Halban and Ludwig Seitz. Translated by Joaquín Núñez Grimaldos with the collaboration of Dr. D. Arcadio Sánchez López. Tomo II. Madrid, 1930

**AMERICAN POCKET MEDICAL DICTIONARY, CONTAINING THE PRONUNCIATION AND DEFINITION OF ALL THE PRINCIPAL TERMS USED IN MEDICINE, SURGERY, DENTISTRY, VETERINARY MEDICINE, NURSING AND KINDRED SCIENCES, WITH OVER 60 EXPLANATORY TABLES** Edited by W. A. Newman Dorland, A.M., M.D. 14th ed. rev. Philadelphia and London W. B. Saunders Company, 1930

**A TEXT BOOK OF MATERIA MEDICA FOR NURSES** By George P. Paul, M.D., C.P.H. (Harvard) 6th rev. ed. Philadelphia and London W. B. Saunders Company, 1930

**STUDIES IN ETHICS FOR NURSES** By Charlotte A. Aikens, R.N. 3d rev. ed. Philadelphia and London W. B. Saunders Company, 1930

**APPLIED BACTERIOLOGY FOR NURSES** By Charles Frederick Boddian, M.D. 6th ed. rev. Philadelphia and London W. B. Saunders Company, 1930

**PROSTHETIC DENTISTRY, AN ENCYCLOPEDIA OF FULL AND PARTIAL DENTURE PROSTHESIS** By Ira G. Nichols, D.D.S. with collaborators St. Louis C. V. Mosby Company, 1930

**THE LONG TREE, AROUND THE WORLD WITH CAMERA AND RIFLE** By Richard L. Sutton, M.D., Sc.D., LL.D., F.R.S. (Edin.), and by Richard L. Sutton, Jr., A.M., B.Sc., M.D. St. Louis The C. V. Mosby Company, 1930

**GONOCOCCAL INFECTION IN THE MALE** By Abr. L. Wolfstam, M.D. 4d rev. ed. St. Louis The C. V. Mosby Company, 1930

**THE EDWIN SMITH SURGICAL PAPYRUS, PUBLISHED IN FACSIMILE AND HIEROGLYPHIC TRANSLITERATION WITH TRANSLATION AND COMMENTARY** By James Henry Breasted. Vols. 1 and 2. Chicago The University of Chicago Press, 1930

**DIATHERMY MEDICAL AND SURGICAL IN OTOLARYNGOLOGY** By Dan McKenzie, M.D. F.R.C.S.E. New York The Macmillan Company, 1930

**DOSE TABLES FOR RÖNTGEN THERAPY** By Prof. Friedrich Voltz. London Oxford University Press, 1930

**APHASIA IN CHILDREN** By Alex. W. G. Ewing, M.A., Ph.D., with an Introduction by E. D. Adrian, M.D., F.R.C.P. F.R.S. London Oxford University Press, 1930

**PRACTICAL MIDWIFERY FOR NURSES** By Bethel Solomons, M.D., F.R.C.P.I., M.R.I.A. New York and London Oxford University Press, 1930

**OUTLINE IN OBSTETRICS FOR NURSES** By F. W. Rice, M.D. St. Louis The C. V. Mosby Company, 1930

**A TEXT BOOK OF HISTOLOGY** By Harvey Ernest Jordan, A.M., Ph.D. New York and London D. Appleton and Company, 1930

# AMERICAN COLLEGE OF SURGEONS

## ORGANIZATION OF SERVICE FOR THE DIAGNOSIS AND TREATMENT OF CANCER

RECOMMENDED BY THE COMMITTEE<sup>1</sup> ON THE TREATMENT OF MALIGNANT DISEASES  
AMERICAN COLLEGE OF SURGEONS

CLINICAL research on cancer has engaged the activities of committees of the American College of Surgeons for the past eight years. The direct relation which the College bears to the surgeons and hospitals of the continent makes possible the assembling of a mass of opinion and experience such as will exceed the experience of any one man and will allow of scientific contributions to our knowledge of cancer that can be obtained in no other way. The co-operation of the Department of Clinical Research of the College with the Department of Hospital Activities makes it possible for the results of the studies to be made immediately available for the hospitals and for contributions from the hospitals to be increased. The Registry of Bone Sarcoma has assembled 1,150 cases of bone tumors that have been studied by the members of the Committee and notable publications have been issued. The Committee on the Treatment of Malignant Diseases has studied cancer of the cervix through some 1,000 case records from twenty two different hospitals and has published five year end results. Similar reports on cancer of the breast have been made, and these and other subjects are still under investigation.

An amplification of this program of the College consists not only in a continuation and extension of these studies, but also in making the present day knowledge of cancer immediately available to the patient in the most effective way through the supervision of the organization and administration of cancer clinics in approved hospitals throughout the continent.

At a meeting of the College held in Chicago, October 17, 1929, the Board of Regents voted to undertake the promotion of better cancer service

throughout the continent and entrusted to the Committee on the Treatment of Malignant Diseases the task of perfecting the details by which this can be accomplished.

The resources available for the diagnosis and treatment of cancer cases at the present time include the following organizations:

- I Cancer institutes
- II Cancer research laboratories
- III Cancer hospitals
- IV Cancer clinics in general hospitals—
  - A Complete cancer clinics,
  - B Diagnostic cancer clinics

It is the fourth type of service which the Committee on the Treatment of Malignant Diseases believes to be the most effective method immediately available for improving the treatment of cancer throughout the continent and for diminishing its present mortality.

While conditions differ markedly in different portions of this country as to the resources available for the diagnosis and treatment of cancer cases, it is certain that for many years to come the vast majority of cases of cancer in this country will be dependent upon the general practitioner, not only for the primary diagnosis of cancer but for the subsequent treatment of the disease as well. With our present resources of surgery and radiation the majority of cases of early local cancer can be cured where the advanced cases can receive no more than palliative treatment.

### I. CANCER INSTITUTES

A cancer institute is an organization equipped with hospitals and laboratories especially organized and conducted for carrying on research in relation to the nature of cancer and its diagnosis and treatment, as well as for the clinical diagnosis and treatment of actual cancer cases. Examples of institutions of this nature are Memorial Hospital, New York, New York State Institute for

<sup>1</sup>The members of the Committee are as follows: A. C. Broders, Rochester, Minnesota; C. F. Burnham, Baltimore; G. W. Cline, Cleveland; B. L. Crowell, Chicago; William Duane, Boston; Edwin C. Ernst, St. Louis; J. M. T. Finney, Baltimore; B. J. Lee, New York; Frank Lynch, New Haven; R. T. Miller, Jr., Baltimore; H. K. Hancock, Philadelphia; H. C. Wells, Chicago; F. C. Wood, New York; and R. B. Green,ugh, Boston. Chairman.

the Study of Malignant Diseases, Buffalo, hospitals and laboratories of the Cancer Commission of Harvard University, Boston, Barnard Free Skin and Cancer Hospital, St. Louis, and Radium Institute, Montreal. Institutes of this nature require very considerable endowments or such generous annual appropriations as can be obtained usually only from the state or national government. They are undoubtedly the most effective method of dealing with the cancer problem but their cost is such that their number will inevitably be somewhat restricted.

## II CANCER RESEARCH LABORATORIES

Laboratories devoted to the study of cancer also exist in a number of medical centers in this country and abroad. The Cancer Research Laboratory of Columbia University, formerly the Crocker Fund, in New York, the Rockefeller Institute in New York, and the Otho S. A. Sprague Memorial Institute in Chicago are examples of institutions of this character, and they again are dependent on large endowments and devote themselves to the investigation of cancer by experimental methods with a view to obtaining knowledge in regard to the nature of the disease. Research of this character is of the greatest importance in contributing to a better control of the disease than is available at the present time, but it is only after a long period of experimentation that the results obtained in the laboratories can be made effective in the actual treatment of the disease in human beings.

## III CANCER HOSPITALS

Hospitals organized and equipped for the diagnosis and treatment of cancer cases have been established in a number of places in this country. Such organizations again require very considerable financial support either by endowment or by annual appropriation. Hospitals of this nature may be supported by the state departments of public health, as in Massachusetts, by state universities, as in the Cancer Institute of the University of Minnesota, or partly by endowment and partly by annual subscription, as in the case of those organized under private enterprise. Institutions of this nature are coming into existence as special departments of existing hospitals in many places.

## IV CANCER CLINICS IN GENERAL HOSPITALS

Where funds sufficient for the maintenance of cancer institutes, research laboratories, or special cancer hospitals are not available, the demand for improved service for cancer cases has resulted in the organization of special cancer

clinics in existing general hospitals and of cancer diagnostic clinics in many places in the country in the past few years. The reason for the organization of these special cancer clinics is primarily the fact that the field of cancer diagnosis and cancer treatment has developed so widely in the past few years that only by the organization of a group of representatives of the different departments of the hospital can the full resources available at the present day for the treatment of cancer be made accessible to the individual patient. Many general hospitals are equipped with the material and apparatus needed for the treatment of cancer, including high voltage X-ray and a sufficient amount of radium, but a separate organization is required to make this equipment available for the cancer patient and to secure the necessary consultation and co-operation from the different members of the hospital staff who are interested and competent in this field.

A complete cancer clinic in a general hospital requires

- 1 Organization of a staff of specialists
- 2 Adequate diagnostic and therapeutic facilities
- 3 Adequate record system
- 4 Clerical assistants
- 5 Social service workers

The movement for the organization of such a clinic may originate within the hospital, it may be developed in response to the demand of the local medical profession for improved service in regard to cancer cases, or it may be promoted by such national organizations as the American College of Surgeons and the American Society for the Control of Cancer. However it originates, such a clinic, if organized in accordance with these general principles, may be made a part of the co-ordinated system of cancer clinics in which the American College of Surgeons is interested and to which the College stands ready to give its assistance and general supervision.

In a large general hospital a cancer clinic of this nature should occupy an intermediate position between the out-patient department and the house service. Tumor cases presenting themselves in any one of the different out-patient departments should be referred to this clinic for study, consultation, and advice in regard to treatment. Tumor cases in the wards of the hospital should be similarly referred for advice in regard to treatment. Certain special technical types of treatment, whether operative or radiological, should be carried out by members of the cancer clinic staff, but for the proper education of the house officers and junior surgeons, operative measures of a

routine character may be entrusted, under supervision, to the regular service of the hospital. In any case, on discharge from the hospital it should be obligatory that tumor cases be referred to the cancer clinic for periodic examination and continued follow up.

The additional expense involved in the maintenance of such a clinic is immaterial, consisting chiefly of clerical and social service cost. It involves merely a redistribution of the work of the hospital in such a way as to bring the cancer cases into the hands of those members of the staff most interested in this work and best equipped to carry it on.

*Staff.* The American College of Surgeons takes the stand that cancer is, in principle, a surgical problem, that the diagnosis and treatment of cancer should be recognized as a responsibility of the surgeon or radiologist who has had surgical training, that he should be qualified for this work by experience in the surgical pathology of tumors and in the employment of radiation methods as well as surgery for both the radical and palliative treatment of cancer, and that he should work in close co-operation and consultation with the radiologist in the use of X-ray treatment.

Such a clinic should have the following staff. The chief of the service should be a responsible member of the surgical department preferably a Fellow of the American College of Surgeons, and he should have associated with him representatives of many of the other departments of the hospital on the cancer clinic staff. Roentgenotherapy and pathology are the two departments which, with surgery, are most concerned in this work, but representatives of the special departments of the hospital should include internal medicine, ophthalmology, otorhinolaryngology, gynecology, genito-urinary surgery and dermatology, and in some cases the dentist, the neurological surgeon and the orthopedic surgeon may be included with advantage. Such a group should work together in constant consultation in determining the plan of treatment to be followed in the individual case and together should consider the progress of the patient as he subsequently returns periodically to the hospital for observation.

*Clerical assistants and social worker.* A clinic of this sort requires adequate clerical assistants for making and preserving records and, in many instances, the assistance of a social service worker to deal with ambulatory cases and assist in maintaining accurate follow-up records.

*Records.* Uniform methods for recording cancer cases will be provided to the end that the data

obtained in all of these clinics may be made complete and comparable one with another in order that accurate statistics in regard to cancer cases may be made available in constantly increasing numbers. Opportunity will be given through the College for periodic reports in regard to the conduct of these clinics, and advice as to the details of organization of the clinic and its conduct will be available from the office of the College in Chicago.

In general, a cancer clinic of this nature should be conducted in such a way that its services are available not only for charity patients but for those who are able to pay in part or in whole the customary hospital and professional fees. To increase the educational value of this service, physicians in private practice should be encouraged to bring their patients to the clinic for consultation, and in any case a report should be sent back to the physician in regard to every case which he sends to the hospital. His co-operation should be secured and maintained in the subsequent periodic examination and treatment of the patient.

The diagnosis of cancer in its early stages is extremely difficult and may be impossible without an exploratory operation. In order that the patient's possibility of cure shall not be jeopardized, such exploratory operations should be conducted only under such conditions that the appropriate treatment, whether by surgery or by radiation, may be carried out immediately when the diagnosis is established by the pathologist by means of a frozen section.

Thus the resources of the general hospital must be made accessible for the early case of cancer as well as for those in which the diagnosis is more readily established, and in availing himself of these resources the general practitioner will have acted in the interest of his patient and provided him with all the resources available in medical science for the cure of cancer, to which every patient in the community, man or woman, may properly consider himself to be entitled. When we consider how little these resources are now utilized for the vast majority of cancer cases, it is not too much to hope that their wider employment will bring a very material reduction in the mortality of this disease.

In summary, then the ideal organization of a complete cancer clinic in a general hospital involves the following considerations.

*Staff.* There should be a chief of clinic as an executive officer, and there should be representatives of the following departments:

- 1 General surgery including gynecology
- 2 X-ray therapy experts

- 3 Radium therapy experts
- 4 A pathologist skilled in tumor pathology
- 5 An internist
- 6 Representatives of the specialties, as follows—genito-urinary surgery, otorhinolaryngology, ophthalmology, dermatology, and neurological surgery

7 Record clerk, follow up system, and social service worker

*Material resources* The material resources should include

- 1 Instruments and laboratories for all general diagnostic methods, such as X-ray, blood chemistry, biology, and various types of endoscopy
- 2 Pathological laboratory service, including frozen section diagnosis convenient to the operating room
- 3 Beds and operating rooms for cases requiring diagnostic operative measures
- 4 Adequate therapeutic service with X ray and radium

*Meetings* Daily, weekly, or semi-weekly sessions of the clinic should be held in accordance with the size of the community served, and weekly or monthly conferences of the whole staff should be made a feature of the clinic exercises

*B Cancer diagnostic clinics* In communities where all of the aforementioned resources are not yet available, but where sufficient professional skill and resources can be obtained for a purely diagnostic consultation clinic service, such a group may be approved by the Committee to function in co operation with other cancer clinics until a more complete organization can be perfected

Cancer diagnostic clinics may be organized in smaller communities where modern X-ray equipment and an adequate supply of radium is lacking. The object in establishing such a clinic is to provide better diagnoses upon cancer patients, to furnish a group judgment concerning the proper means of therapy to be employed, and to educate the medical public concerning this important group of diseases. Medical men in the community should be encouraged to bring patients to such a clinic, accompanied by a complete record of the history and physical examination. When a diagnosis shall have been reached and a line of treatment suggested, the surgeon or physician will be free to continue the care of his own patient as he may see fit

The most important activity of such a clinic is the conference held at least once a week. These conferences may be carried on in one particular hospital or, if the local situation demands, upon alternate weeks at adjacent hospitals. The conference permits a free exchange of ideas and

eliminates the special bias of any one individual in dealing with a patient. The diagnosis of cancer may be extremely difficult and the best judgments rendered are by groups of men interested in this subject. At such a conference interesting pathological material may be presented. The members of the clinic and physicians in the community should be encouraged to present in the conference patients who have been previously seen and have been subjected to various forms of treatment. The conference, therefore, becomes an important educational activity of the clinic.

The personnel for such a diagnostic clinic is as follows: (1) A director, preferably a surgeon chosen because of his powers of leadership, technical training, knowledge of the subject, and enthusiasm, (2) one or more surgeons, (3) pathologist, (4) roentgenologist, (5) internist, (6) gynecologist, (7) dermatologist, (8) urologist, and (9) gastro-enterologist.

It may not be possible to organize a staff on such an ample basis and men in other special fields, who have unusual interest in cancer, may supplant some of those mentioned.

A consulting staff of specialists may be added to serve as special consultants. A secretary or social worker should be the active clerical manager of the clinic. Her duties comprise the making of records of the patients and the filing of these records at the clinic, the control of the follow-up of the patients presented through correspondence with the referring physician, and, in co-operation with the director, the preparation of the program for each of the regular conferences.

Women volunteer workers from local cancer committees may be useful in carrying on some of the clerical work, and junior and senior medical students may, upon occasion, serve in a similar capacity.

Indigent patients should be referred for treatment to the hospital in which they originated. In all other cases patients are returned, with diagnosis and recommendations, to the referring physician. Such a co-operative effort is a first step which may eventually lead to a fully organized cancer clinic with adequate therapeutic facilities. The cancer diagnostic clinic will serve as an important educational influence among the medical men of the community, and cancer patients will receive more accurate diagnoses and better treatment.

#### RELATION OF THE AMERICAN COLLEGE OF SURGEONS TO THE CANCER CLINICS

The American College of Surgeons through its Committee on the Treatment of Malignant

*Diseases, Department of Clinical Research, will co-operate with the cancer clinics in the following respects*

It will furnish to men and hospitals desiring to form such clinics information as to the methods to be adopted in the organization of the clinics

It will put the stamp of approval of the College on such clinics as conform to the standards of the College for such clinics

It will furnish to the clinics samples of uniform record blanks for the recording of their cases

It will ask the clinics to co operate in furnishing data on their cases for a scientific study of the results of treatment by various methods This study will be a continuation of the studies that the Committee has been making during several

years on data furnished by a limited number of selected clinics

It will furnish the clinics with an opportunity of discussing their administrative problems in a series of round table conferences at each of the annual Clinical Congresses of the College and at the sectional meetings of the College which are held throughout the country each year

It will publish and distribute to the clinics the results of its studies, based on the data collected, after analysis by the Committee

It will issue in the *Bulletin* of the College from time to time articles dealing with the administrative and scientific phases of the clinic work, and the proceedings of such round table conferences and symposiums as may be held

It will co-operate with the clinics in such other ways as may be to their advantage

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

MERRITTE W. IRELAND, Washington, *President*

C. JEFF MILLER, New Orleans, *President Elect*

FRANKLIN H. MARTIN, Chicago, *Director General*

## PHILADELPHIA EXECUTIVE COMMITTEE

E. L. ELIASON, *Chairman*

DRURY HINTON, *Secretary*

BROOKE M. ANSPACH

FIELDING O. LEWIS

CHARLES F. NASSAU

LOUIS H. CLERF

GEORGE P. MULLER

DAMON B. PFEIFFER

JOHN D. ELLIOTT

WILLIAM J. MERRILL

JOHN S. RODMAN

FLOYD E. KEENE

WILLIAM T. SHOEMAKER

## PROGRAM FOR THE 1930 CLINICAL CONGRESS IN PHILADELPHIA

### PHILADELPHIA PROGRAM IN BRIEF

*Friday, October 17*

All sessions at the Bellevue Stratford except as noted

#### *Monday, October 13*

- 9 30 Hospital conference
- 2 00 Clinics in the hospitals
- 2 00 Hospital conference
- 8 15 Presidential Meeting

#### *Tuesday, October 14*

- 9 00 Clinics in the hospitals
- 9 00 Clinical demonstrations—eye, ear, nose and throat
- 9 30 Hospital conference
- 10 00 Surgical film exhibition
- 2 00 Clinics in the hospitals
- 2 00 Surgical film exhibition
- 2 00 Hospital conference
- 8 15 Scientific session

#### *Wednesday, October 15*

- 9 00 Clinics in the hospitals
- 9 00 Clinical demonstrations—eye, ear, nose and throat
- 9 30 Hospital conference
- 10 00 Surgical film exhibition
- 2 00 Clinics in the hospitals
- 2 00 Surgical film exhibition
- 2 00 Hospital conference
- 4 00 Symposium on electro-surgery
- 8 15 Scientific session

#### *Thursday, October 16*

- 9 00 Clinics in the hospitals
- 9 00 Clinical demonstrations—eye, ear, nose and throat
- 9 30 Conference on Cancer Clinics, Institutes, and Hospitals
- 10 00 Surgical film exhibition
- 2 00 Annual meeting of the College
- 3 00 Symposium on Cancer
- 8 15 Scientific session

- 9 00 Clinics in the hospitals
- 9 00 Clinical demonstrations—eye, ear, nose and throat
- 10 00 Surgical film exhibition
- 10 00 Conference on Traumatic Surgery
- 11 00 Meeting of new fellows
- 2 00 Clinics in the hospitals
- 2 00 Conference on Traumatic Surgery
- 2 00 Surgical film exhibition
- 8 15 Convocation

THE surgeons of Philadelphia have prepared and will present during the twentieth annual Clinical Congress of the American College of Surgeons, beginning Monday, October 13th, and ending Friday, October 17th, a comprehensive program of clinics and demonstrations in the hospitals and medical schools of that city that will completely represent the clinical activities of that great medical center in all departments of surgery. The program as published in the following pages may be considered as an outline for the complete clinical program for the five days' session. The real program of the Congress will be issued daily in the form of bulletins. These will be posted at headquarters each afternoon presenting the clinical schedules for all hospitals for the following day. Printed bulletins containing the same material with complete programs for all conferences, scientific sessions, etc., will be distributed each morning.

It will be noted that the program provides for operative clinics and demonstrations beginning at 2 o'clock on Monday afternoon, October 13th, and



for each morning and afternoon of the following four days

An important feature of the clinical program will be a series of fracture clinics demonstrating modern methods in the treatment of fractures. Plans are being made by the Committee on Arrangements for a comprehensive showing at several of the larger hospitals of the methods employed and the results obtained in the treatment of fractures, which form so large a part of the surgical work in industrial centers and large cities.

Clinical demonstrations in ophthalmology and otolaryngology will be held in the ballroom of the Bellevue Stratford Hotel each morning except Monday, beginning at 9 o'clock, in view of the fact that the clinical work in these specialties will be presented at the hospitals in the afternoons. The complete program for these demonstrations will be found in the following pages.

An exhibition of surgical films, both talking and silent, will be conducted at headquarters daily except on Monday. At these exhibitions the motion picture films that have been produced under the supervision of, or approved by, the Board on Medical Motion Pictures of the College will be exhibited. The program will also include other outstanding contributions not comprised in the College library of films.

At the annual meeting of the College, on Thursday afternoon at 2 o'clock, formal reports on the activities of the College will be presented by the officers and several standing committees followed by the election of officers. At the conclusion of the annual meeting a symposium on cancer dealing with the scientific aspects of this problem will be presented.

Plans for the entertainment of visiting ladies are being made by the Executive Committee, and it is probable that a series of automobile tours visiting the important historic points in and around Philadelphia will be arranged. A special registration desk and information bureau for the ladies will be provided.

#### COMMITTEE ON ARRANGEMENTS

In addition to the Executive Committee as listed above, the following representatives of hospitals and medical schools are members of the Committee on Arrangements: Leon T. Ashcraft, W. Wayne Babcock, William Bates, John A. Brooke, H. P. Brown, Ralph Butler, B. F. Buzby, G. M. Dorrance, L. D. Englerth, Ralph Goldsmith, J. Milton Griscom, Robert Kimbrough, Edward J. Klopp, A. D. Kurtz, Benjamin Lipshutz, Clifford Lull, P. A. McCarthy, J. J. A. McMullin, George M. Marshall, George H.

Meeker, William E. Parke, William N. Parkinson, Ross V. Patterson, William Pepper, William Pierson, Warren Reese, Desiderio Roman, Thomas J. Ryan, William Sheehan, Calvin Smyth, John Speese, Margaret Sturgis, William B. Swartley, Roscoe Teahan, T. Turner Thomas, Martha Tracy, Stephen E. Tracy, Frank White.

#### HEADQUARTERS

Clinical Congress headquarters will be established at the Bellevue Stratford Hotel, corner of Broad and Walnut Streets. All of the large rooms on the first floor, including the grand ballroom which will be used for the evening scientific meetings, the hospital conference on Monday, the annual meeting and other large gatherings, together with several of the large rooms on the roof and the Stratford room on the main floor, have been reserved for the use of the Congress, and will be utilized for scientific meetings, conferences, film exhibitions, registration and ticket bureaus, bulletin boards, executive offices, scientific and technical exhibitions, etc.

Space has been reserved in the Stratford Room on the main floor, the Clover and Red Rooms and other large rooms on the first floor, for the Technical Exhibition in which will be represented the leading manufacturers of surgical instruments, X-ray apparatus, operating lights, hospital apparatus of all kinds, pharmaceuticals, publishers of medical books, etc.

#### EVENING MEETINGS

In the following pages will be found the complete programs for the five evening sessions as arranged by the Executive Committee. All of these meetings will be held in the ballroom of the Bellevue Stratford Hotel. At the Presidential Meeting on Monday evening, following the introduction of distinguished guests from abroad, the retiring president, Major General Merritt W. Ireland, Washington, will give a brief address and introduce the president elect, Dr. C. Jeff Miller, of New Orleans. Mr. George Grey Turner, Newcastle upon Tyne, England, professor of surgery in the University of Durham and Hunterian professor of the Royal College of Surgeons of England, will deliver the Murphy oration in surgery that evening.

Dr. George W. Crile, of Cleveland will deliver the Fellowship address at the annual Convocation of the College on Friday evening, at which time the 1930 class of candidates for Fellowship in the College will be received.

Dr. Dallas B. Phenister, professor of surgery at the University of Chicago, will deliver the

annual oration on fractures on Wednesday evening

#### CANCER CONFERENCE AND SYMPOSIUM

A round table conference under the auspices of the Committee on the Treatment of Malignant Diseases, with Burton J Lee, M D, New York, presiding, to be held in the ballroom at 9 30 on Thursday morning, will deal with the subject of cancer clinics, cancer hospitals and cancer institutes, for the discussion of plans for the organization and administration of such institutions. Members of the Committee will present methods recommended by the Committee for securing more widespread efficient care for cancer patients. Representatives of existing and proposed cancer clinics of various types will be given an opportunity to present questions on the administration and professional conduct of such clinics.

**Cancer Hospitals** JAMES EWING, M D, New York, and BURTON T SIMPSON, M D, Buffalo  
**Discussion by** ROBERT H FIFE, M D, Atlanta, and ERNEST M DALAND, M D, Boston

**Cancer Clinics in General Hospitals** ROBERT B GREENOUGH, M D, Boston, and JOHN T MORTON M D, Rochester, N Y  
**Discussion by** JONATHAN WAINWRIGHT, M D, Scranton

**Diagnostic Cancer Clinics** HERBERT R CHARLTON, M D, Bronxville, N Y and OWEN H WANGENSTEEN, M D, Minneapolis  
**Discussion by** HERBERT L LOMBARD, M D, Boston

In the afternoon following the annual meeting and under the auspices of the same Committee, a symposium on cancer will be presented, the program for which follows

**Report of the Committee on the Treatment of Malignant Diseases** ROBERT B GREENOUGH, M D, Boston, Chairman

**Eleven Years' Experience with the Radium Treatment of Carcinoma of Cervix Uteri at the Woman's Hospital** GEORGE GRAY WARD, M D, New York

**Some Phases of Rectal Cancer** WILLIAM ERNEST MILES, F R C S, London, England

**Epiphyseal Chondromatous Tumors of the Upper End of the Humerus** ERNEST AMORY CODMAN M D, Boston

**Muscle Involvement in Breast Cancer Its Relation to the Question of Treating Primary Operative Cases by Radiation** JONATHAN WAINWRIGHT, M D, Scranton

Preparations are being made at some of the Philadelphia hospitals where cancer clinics are being conducted for demonstrations and dry clinics dealing with aspects of the cancer problem

#### CONFERENCE ON ELECTRO SURGERY

The value of electro-surgery as an adjunct to the armamentarium of the surgeon is the subject of a co-operative clinical investigation that is being carried on throughout the country under

the Department of Clinical Research of the College. A symposium on this subject will be held on Wednesday afternoon, in the ballroom, beginning at 4 o'clock, when the evolution of electro-surgery will be discussed and practical experiences by surgeons representing the surgical specialties will be presented. Modern advances in the knowledge of electricity have made possible this addition to surgical equipment. The program follows

**Outstanding Features in the Development of Electro Surgery** HOWARD A KELLY, M D, Baltimore  
**Radiofrequency in Electro Surgery** N H LOWRY, M D, Chicago

**The Electro Surgical Unit as an Aid to the Neurosurgeon** ERNEST SACHS, M D, St. Louis

**The Electro Surgical Unit as an Aid in General Surgery** HOWARD LILLIENTHAL, M D, New York, and OSCAR E NADEAU, M D, Chicago

**Electro Surgery in Diseases of the Thyroid** MARTIN B TINKER, M D, Ithaca, N Y

**Electro Surgery in Diseases of the Genito Urinary System** EDWARD L KEYES, M D, New York

**Tensile Strength of Wounds** JOHN D ELLIS, M D, Chicago

**Electro Surgery in the Treatment of Malignant Diseases** ARTHUR CARROLL SCOTT, M D, Temple, Texas

**Some Phases of Electro Surgery, Discussion from the Experimental Standpoint** H F PIERCE, M D, and A L MACLEAN, M D, Baltimore

#### CONFERENCE ON TRAUMATIC SURGERY

A conference on traumatic surgery has been arranged for Friday, with sessions both morning and afternoon, at which leaders in industry, education and labor, together with the representatives of indemnity companies, surgeons and hospital administrators, will discuss various phases of this activity of the College. The program for the conference includes the following

**Report on the Work of the Committee on Traumatic Surgery in Recent Years Its Present and Future Activities** FREDERIC A BESLEY, M D, Waukegan, Ill., Chairman

**Injuries to the Shoulder Joint** ERNEST AMORY CODMAN, M D, Boston

**Treatment of Injuries of the Knee Joint** WILLIS C CAMPBELL, M D, Memphis, Tenn.

**Treatment of Fractures by Skeletal Traction** SAMUEL R CUNNINGHAM, M D, Oklahoma City, Okla.

**Injuries of the Head** GEORGE W SWIFT, M D, Seattle, Wash.

**Workmen's Compensation Laws in Canada** FREDERICK J TEES, M D, Montreal

**Application of the Compensation Act in the State of New York** LINDSAY ROGERS, New York

**Discussion of the Automobile Accident Situation in Relation to Payment for Hospital Care** EMIL FRANKEL, Director of Research, New Jersey Department of Institutions and Agencies, Trenton, N J

**Physical Therapy in Fractures of Both Bones of the Leg** JOHN S COULTER, M D, Chicago

**The Immediate Care of Injuries of the Hand** SUMNER L KOCH, M D, Chicago

## HOSPITAL STANDARDIZATION CONFERENCE

The thirteenth annual hospital standardization conference opens at 9 30 o'clock on Monday morning, October 13, in the ballroom of the Bellevue Stratford Hotel. An interesting program of papers, round table conferences, and practical demonstrations that deal with the problems related to the hospital standardization program of the College and to hospital efficiency in general has been prepared. All persons interested in the hospital field are invited to attend this conference.

Monday, 9 30-12 00

- Opening Address MAJOR GENERAL MERRITT W. IRELAND Washington, President, American College of Surgeons
- Presentation of the Thirteenth Annual Report of Hospital Standardization FRANKLIN H. MARTIN M.D. Chicago Director General American College of Surgeons
- Our Responsibility as Fellows of the College in Furthering the Hospital Standardization Movement C. JEFF MILLER M.D. New Orleans President Fleet American College of Surgeons
- What the Hospital Standardization Movement Means to the Present Day Practice of Medicine GEORGE W. CARLE M.D. Cleveland Director, Cleveland Clinic
- My Concept of an Ideal Hospital REV. ALPHONSE M. SCHWITALLA St. Louis Dean St. Louis University School of Medicine, President, Catholic Hospital Association
- Is Standardization of Hospital Surgical Procedures Possible? JOSEPH C. DOVE M.D., Philadelphia, Director Jewish Hospital
- The Liaison Committee—a Means of Promoting Cooperation Between the Medical Staff and the Hospital Management J. GARLAND SHERRILL M.D. Louisville Visiting Surgeon Louisville Public, Jewish, and St. Mary and St. Elizabeth Hospitals
- Discussion by WALTER W. CHIPMAN M.D. Montreal, Emeritus Professor of Gynecology and Obstetrics McGill University Faculty of Medicine

Monday 2 00-5 00

- FRANK D. JENNINGS M.D. Brooklyn Clinical Professor of Surgery, Long Island College Hospital, Surgeon, St. Catherine's Hospital presiding
- A Study of Acute Appendicitis at St. Catherine's and Greenpoint Hospitals Brooklyn from 1919 to 1930 inclusive for the Purpose of Evaluating the Benefit of Staff Conferences JOSEPH S. BALOWIN M.D., Attending Surgeon Greenpoint and Holy Family Hospitals, HARRY FELDMAN M.D., Associate Surgeon Greenpoint Hospital, JOHN A. McCABE M.D. Assistant Surgeon Greenpoint and St. Catherine's Hospitals, JOSEPH L. IFEITER M.D., Assistant Surgeon St. Catherine's Hospital WALTER J. O'CONNELL M.D., Assistant Surgeon St. Catherine's Hospital
- Co-ordination and Integration of the Gynecological Obstetrical Service in a General Hospital CHARLES A. GORDON, M.D., Brooklyn, Clinical Professor of Obstetrics and Gynecology Long Island College Hospital Attending Obstetrician and Gynecologist, Greenpoint and St. Catherine's Hospitals

- A Plan for the Organization and Control of the Courtesy Staff in a General Hospital JOHN M. SCANNELL, M.D. Jamaica, N.Y. Attending Surgeon St. Catherine's Hospital, Brooklyn Attending Surgeon Mary Immaculate Hospital Jamaica
- Problems of the Rural Surgeon and Their Solution JOHN B. MCKENZIE M.D., Loggville, N.B. Surgeon Hotel Dieu, Chatham
- Is the Private Patient Getting a Square Deal? JOHN E. JENNINGS M.D. Brooklyn Surgeon in Chief Cumberland Hospital, Surgeon Brooklyn and St. Peter's Hospitals
- Discussion by H. L. FOSS M.D. Danville Penn. Surgeon in Chief George F. Gensinger Memorial Hospital

Tuesday, 9 30-12 30

- PHILIP H. KREUSCHER M.D., Chicago, Professor of Clinical Orthopedic Surgery, Loyola University School of Medicine, presiding
- Important Basic Considerations in Maintaining an Adequate X-ray Service in Various Sized Hospitals EDWARD S. BLAINE M.D., Chicago, Radiologist, Wesley Memorial Hospital
- Autopsies Their Value and Certain Factors that Will Influence Their Increase B. HENRY MASON, M.D., Waterbury Conn., Superintendent Waterbury Hospital
- Absorption of Special Charges in Hospitals (Illustrated) LAWRENCE C. ALSTIN, Milwaukee, Superintendent Mount Sinai Hospital
- The Hospital's Teaching Responsibility JOHN E. RAYSON, Baltimore Assistant Director Johns Hopkins Hospital
- Discussion by W. P. MORRILL, M.D., Portland Maine, Superintendent Maine General Hospital

Tuesday 2 00-5 00

- Round Table Conference—Functions, Relationships and Responsibilities of the Board of Trustees Medical Staff and Superintendent Conducted by C. W. MUNCER M.D. Valhalla N.Y. Director Westchester County Department of Hospitals
- The Relative Functions of Trustees Medical Staffs and Administrators E. M. BLUESTONE M.D., New York Director, Montefiore Hospital
- Discussion opened by T. D. SLOAN M.D., New York Superintendent New York Post Graduate Medical School and Hospital
- The Responsibility of the Medical Staff in and to the Administration of the Hospital JOSEPH TENOPPE M.D. Brooklyn Attending Surgeon, Caledonian Hospital
- Discussion opened by PAUL KELLER M.D. Newark Director Beth Israel Hospital
- The Role of the Department of Nursing in the Promotion of the Medical and Administrative Aims of the Hospital MARIAN ROTTMANN R.N. New York, Director of Nursing Department of Hospitals
- Discussion opened by ELIZABETH A. GREENER R.N. New York, Director of Nursing Mount Sinai Hospital
- Social Service as an Aid to the Administrator and the Attending Staff FISA BUTLER GROVE, New York Teachers College, Columbia University
- Discussion opened by LENA R. WATERY, Philadelphia University Hospital

Wednesday, 9 30-12 30

- R C BUERKE, M D, Madison, Wis., Superintendent  
State of Wisconsin General Hospital, presiding
- Organization of the Record Department (illustrated)  
PAUL H FESLER Minneapolis; Superintendent,  
University Hospitals
- Centralization of Medical Statistics in the Record Department  
MARY H NEWTON, R N, Pittsburgh Medical  
Statistician, Pittsburgh Homeopathic Hospital
- Role of the Student Nurse in the Clinical Record  
MARY MERRILL, Williamsport Student Nurse, School of  
Nursing, Williamsport Hospital
- Case Records and Staff Conferences  
IRVIN D METZGER,  
M D, Pittsburgh, President, Pennsylvania State  
Board of Medical Education and Licensure
- Discussion by JOSEPH TURNER, M D, New York, Di-  
rector, Mount Sinai Hospital

Wednesday, 2 00-5 00

- Round Table Conference—Medical and Hospital Economics  
Conducted by ROBERT JOLLY, Houston, Texas,  
Superintendent, Baptist Hospital Educating the  
Public, Costs versus Value of Medical and Hospital  
Services, Medical and Hospital Economics in relation  
to planning and construction, management, scientific  
departments (clinical laboratory, X ray and physical  
therapy) medical services, Standardization of Equip-  
ment and Supplies, and other practical problems

Those attending the hospital conference are invited to attend a round table conference on the subject of cancer clinics, cancer hospitals and cancer institutes, Thursday morning and a conference on traumatic surgery on Friday morning. The afternoons of those two days will be devoted to visits to the Philadelphia hospitals with demonstrations on hospital equipment, construction, management, etc

#### REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Philadelphia session of the Clinical Congress so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to Philadelphia, procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be deposited at headquarters for the signature of the general manager of the Clinical Congress and the vise of a special agent of the railways. Upon presentation of a valid certificate to the ticket agent in Philadelphia not later than October 21st a ticket for the return journey by the same route as traveled to Philadelphia may be purchased at one half the one-way fare.

In the eastern, central and southern states and eastern provinces of Canada tickets may be purchased between October 9th and 15th, in other sections of the United States and Canada at somewhat earlier dates. The return journey from Philadelphia must be begun not later than October 21st.

The reduction in fares does not apply to Pullman fares, nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to Philadelphia, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and used by a special railroad agent in Philadelphia during the meeting. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used to Philadelphia and that the certificate must be deposited at headquarters during the meeting and return ticket purchased and used not later than October 21st.

#### SPECIAL TRAIN FROM CHICAGO

For the convenience of men living in the central and western states who will attend the Congress in Philadelphia, the Pennsylvania Railroad will undertake to provide a special train leaving Chicago at 1 45 p m on Sunday, October 12th, arriving in Philadelphia at 8 45 a m on Monday, October 13th. This special train will duplicate the equipment and schedule of the famous Broadway Limited, and will include standard Pullman sleeping, compartment, club, observation and dining cars. No extra fare will be charged for passage on this special train.

Members are urged to make their reservations for the special train at the earliest possible date through their local ticket agents or by direct application to Mr R C Caldwell, Division Passenger Agent, Pennsylvania Railroad, 33 North LaSalle Street, Chicago. The proposed arrangement is contingent upon reservations for such special train being made by the minimum number required by the Interstate Commerce Commission rules.

## PROGRAM FOR EVENING MEETINGS

## GRAND BALLROOM, THE BELLEVUE-STRATFORD

*Presidential Meeting—Monday, 8 15 P M*

Address of Welcome ELDRIDGE L. ELIASON, M D, Philadelphia, Chairman of Committee on Arrangements  
 Address of Retiring President Military Obligations of the Medical Profession MAJOR GENERAL MERRITT  
 W IRELAND, Washington  
 Introduction of Foreign Guests  
 Inaugural Address The Humanities of Medicine C JEFF MILLER, M D, New Orleans  
 The John B. Murphy Oration in Surgery Ideals and the Art of Surgery PROFESSOR GEORGE GREY  
 TURNER Newcastle upon Tyne, England

*Tuesday, 8 15 P M*

Symposium Urologic Surgery—Surgery of the Kidneys Bladder and Ureters  
 HENRY WADE C M G D S O, F R C S, Edinburgh Scotland The Treatment of Malignant Disease  
 of the Urinary Bladder  
 WILLIAM E. LOWER, M D, Cleveland Diverticula of the Urinary Bladder  
 FRANCIS R. HAGNER, M D, Washington Operation for Sterility  
 DAVID W. MACKENZIE, M D, Montreal Tumors of the Testis  
 WILLIAM ERNEST MILES, F R C S, London England Pathology of the Spread of Cancer of the Rectum  
 and Its Bearing upon Its Surgical Treatment

*Wednesday, 8 15 P M*

Symposium Plastic Surgery—Treatment of Burns, Injuries, Contractures, and Congenital Deformities  
 PROFESSOR OTFRIED FOERSTER, Breslau, Germany Surgical Treatment of Neurogenic Contractures  
 SUMNER L. KOCH, M D, Chicago Contractures of the Hand  
 DALLAS B. PHENISTER, M D, Chicago Fracture Oration—Splint Grafts in the Treatment of Delayed  
 Union and Non Union of Fractures

*Thursday, 8 15 P M*

Symposium Thoracic Surgery  
 AMBROSE L. LOCKWOOD, M D, Toronto Fundamental Principles in the Treatment of Acute Empyema  
 GEORGE J. HEUER, M D, Cincinnati Etiology and Treatment of Pulmonary Abscess  
 STUART W. HARRINGTON, M D, Rochester, Minnesota Surgical Treatment of Tumors of the Lung  
 and Mediastinum  
 CARL A. HEDBLUM, M D, Chicago Diagnosis and Treatment of Bronchiectasis  
 Discussion by ALTON OCHSNER, M D, New Orleans, GEORGE P. MULLER, M D, PHILADELPHIA  
 Experiments in Efforts to Transfer Monkey Malaria to Man HERBERT C. CLARK, M D, Director, Gorgas  
 Memorial Laboratory Panama

*Convocation—Friday, 8 15 P M*

Invocation REVEREND DOCTOR FLOYD W. TOMKINS, Philadelphia  
 Conferring of Honorary Fellowships  
 Presentation of Candidates for Fellowship, Class of 1930  
 Presidential Address The Doctors of Fiction C JEFF MILLER, M D, New Orleans  
 Fellowship Address GEORGE W. CRILE, M D, Cleveland Obligations of the American College of Sur-  
 geons to Medicine and to the Public

## PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS,  
PROCTOLOGY, SURGICAL PATHOLOGY, ETC

## UNIVERSITY HOSPITAL

## Tuesday

- CHARLES C NORRIS, C A BEHNEY and D P MURPHY—9  
Gynecological operations and demonstration of cases  
GEORGE P MULLER, R H OVERHOLT and L A RADE  
MAKER—9 Surgical clinic, abdominal cases  
EDMUND B PIPER and staff—9 Obstetrical operations  
C H FRAZIER and F C GRANT—9 Neurosurgical clinic  
GABRIEL TUCKER—9 Bronchoscopy  
GEORGE P MULLER, R H OVERHOLT and L A RADE  
MAKER—2 Dry clinic Special tests used in the study  
of vascular disturbances, opaque solutions available in  
the roentgenological study of surgical patients,  
factors in the production of chills following intravenous  
infusions, intraperitoneal and intrapleural pressure  
relationships, the course of events in acute appendi-  
citis  
I S RAYDIN—2 Gall bladder surgery operations and  
demonstration of cases  
C H FRAZIER and F C GRANT—2 30 Neurosurgical  
clinic, demonstration of interesting cases

## Wednesday

- CHARLES C NORRIS and staff—9 Gynecological operations  
and demonstration of cases  
E L ELIASON and staff—9 General surgical clinic  
F C GRANT—9 Neurosurgical clinic  
A BRUCE GILL and staff—2 Orthopedic surgery, dry  
clinic with demonstration of end results  
ALEXANDER RANDALL and staff—2 Urological operations  
and demonstration of cases

## Thursday

- C H FRAZIER and F C GRANT—9 Neurosurgical opera-  
tions  
GEORGE P MULLER, R H OVERHOLT and L A RADE  
MAKER—9 Surgical clinic thoracic cases, operations  
and demonstration of cases  
EDMUND B PIPER and staff—9 Obstetrical operations  
FLOYD E KEENE and staff—9 Gynecological operations  
GEORGE P MULLER, R H OVERHOLT and L A RADE  
MAKER—2 Dry clinic Results in the surgical treat-  
ment of lung abscess, methods of treating empyema,  
presentation of follow up chest cases of lung abscess,  
bronchiectasis, chronic empyema and pulmonary  
tuberculosis  
A BRUCE GILL and staff—2 Orthopedic operations  
B J ALPERS—2 30 Neuropathological conference

## Friday

- C H FRAZIER—9 Neurosurgical clinic  
GABRIEL TUCKER—9 Bronchoscopy  
FLOYD E KEENE and staff—9 Gynecological operations  
EDMUND B PIPER—9 Obstetrical operations  
E L ELIASON and staff—9 Fracture clinic  
L K FERGUSON—1 30 Treatment of varicose veins by  
injection method

## GERMANTOWN HOSPITAL

## Wednesday

- WILLIAM B SWARTLEY—10 General surgery

## Friday

- WILLIAM B SWARTLEY—10 General surgery

## LANKENAU HOSPITAL

## Monday

- JOHN B DEEVER—12 General surgical clinic  
WILLIAM MACKINNEY—3 Cystoscopy

## Tuesday

- STANLEY REIMANN and staff—9 Exhibit of pathological  
specimens and demonstration of laboratory tests  
DR HAMMETT—9 Chemistry of cell division  
ELIZABETH MCNETT—9 Exhibition of drawings of  
pathological specimens  
ANNIE JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration

## Wednesday

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DR HAMMETT—9 Chemistry of cell division  
ELIZABETH MCNETT—9 Exhibition of drawings of  
pathological specimens  
COLBY ENGEL—9 Injection treatment of varicose veins  
STANLEY REIMANN and BENJAMIN GRUSKIN—10 Dem-  
onstration of a serological test for the presence or  
absence of cancer  
ANNIE JASTROW—11 Exhibition of follow up service  
ROBERT SHOEMAKER—11 X ray demonstration  
JOHN B DEEVER—12 General surgical clinic

## Thursday

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ROBERT SHOEMAKER—11 X ray demonstration  
WILLIAM MACKINNEY—3 Cystoscopy

## U S NAVAL HOSPITAL

## Tuesday

- JOSEPH J A McMULLIN—9 Surgical operations

## Wednesday

- JOSEPH J A McMULLIN—9 Surgical operations

## Thursday

- JOSEPH J A McMULLIN—9 Surgical operations

## Friday

- JOSEPH J A McMULLIN and M E ASTON—2 Discussion  
of tuberculosis of the cecum Bant's disease, tuber-  
culosis of the kidney, hypernephroma

## TEMPLE UNIVERSITY HOSPITAL

## Monday

WILLIAM A STEEL—1 Surgical operations  
 W HERSEY THOMAS—3 Genito urinary surgery  
 TEMPLE FAY—3 Encephalography  
 W EDWARD CHAMBERLAIN—3 Surgical radiological conference

## Tuesday

TEMPLE FAY—9 Neurosurgical clinic brain tumors  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND II A DUNCAN and C S MILLER—  
 11 Operative gynecology  
 HARRY HUDSON—1 Orthopedic surgery  
 TEMPLE FAY—3 Management of traumatic injuries to the brain  
 W EDWARD CHAMBERLAIN—3 Surgical radiological conference  
 FRANK W KONZELMANN—3 Surgical pathological conference

## Wednesday

WILLIAM N PARKINSON and W EMORY BURNETT—9  
 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic spinal cord tumor cases  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND II A DUNCAN and C S MILLER—  
 12 Operative gynecology  
 WILLIAM A STEEL—11 General surgical operations  
 TEMPLE FAY and NATANIEL WINKELMAN—3 Atypical neuralgia and trigeminal neuralgia  
 H Z HIBSHMAN—3 Rectal surgery  
 W EDWARD CHAMBERLAIN—3 Surgical radiological conference

## Thursday

TEMPLE FAY—9 Neurosurgical clinic cerebellar tumor case  
 W WAYNE BABCOCK—10 General surgical operations  
 FRANK C HAMMOND II A DUNCAN and C S MILLER—  
 12 Operative gynecology  
 WILLIAM A STEEL—12 Buerger's clinic, operative and ambulant cases  
 JESSIE ARNOLD—1 Obstetrics  
 TEMPLE FAY—3 Neurosurgical clinic cerebral hydration states in eclampsia and uremia and acute toxic condition  
 W EDWARD CHAMBERLAIN—3 Surgical radiological conference  
 FRANK W KONZELMANN—3 Surgical pathological conference

## Friday

T M ASTLEY J H FRICK and J N COOMBS—9 General surgical operations  
 TEMPLE FAY—9 Neurosurgical clinic gangliectomy or sympathectomy  
 W WAYNE BABCOCK—10 General surgical operations  
 LOUIS COHEN—10 Artificial pneumothorax on ambulant patients  
 FRANK C HAMMOND II A DUNCAN and C S MILLER—  
 12 Operative gynecology  
 WILLIAM A STEEL—1 Operative surgery  
 W HERSEY THOMAS—3 Genito urinary operations  
 TEMPLE FAY—3 Neurosurgical clinic  
 W EDWARD CHAMBERLAIN—3 Surgical radiological conference

## GRADUATE HOSPITAL

## Monday

WALTER G FLINER—12 30 Orthopedic operations  
 GEORGE E PFÄHLER—2 Dry clinic Radiation and diagnosis of malignant diseases  
 GEORGE M PIERSON—2 Ward rounds cardiorenal cases  
 ORLANDO H PETTY—4 Ward rounds diabetic cases  
 B C HIRST—5 Diagnostic gynecological clinic

## Tuesday

WALTER E LEE—9 General surgical operations  
 H L BOCKUS—9 Dry clinic Diagnosis of gastrointestinal disease  
 WILLIAM R NICHOLSON—9 Diagnostic gynecological clinic  
 OFFOREST P WILLARD—10 30 Operative orthopedics  
 B C HIRST—11 Operative gynecology  
 WILLIAM H MACKINNEY—2 Genito urinary surgery  
 ORLANDO H PETTY—4 Ward rounds diabetic cases

## Wednesday

WILLIAM R NICHOLSON—9 Operative gynecology  
 JOHN H JOHNSON—9 General surgical operations  
 J K JAFFE—9 Cystoscopic clinic  
 WALTER G FLINER—12 Orthopedic operations  
 WILLIAM H MACKINNEY—2 Genito-urinary surgery  
 H L BOCKUS—2 Ward rounds gastro-intestinal diagnosis  
 EUGENE A CASE—2 Surgical pathology, laboratory display of gross and microscopic sections  
 GEORGE M PIERSON—2 Ward rounds cardiorenal cases  
 GEORGE E PFÄHLER—2 Radiation and diagnosis of malignant diseases  
 ORLANDO H PETTY—4 Ward rounds diabetic cases

## Thursday

COLLIER F MARTIN and W OIKLEY HERMAN—9  
 Surgery of rectal infections  
 CARLIEL TILGNER—9 Bronchocopy  
 B C HIRST—17 Operative gynecological clinic  
 EUGENE A CASE—2 Surgical pathology laboratory display of gross and microscopic sections  
 ORLANDO H PETTY—4 Ward rounds, diabetic cases  
 GEORGE M BOYD—5 Diagnostic gynecological clinic

## Friday

J B CARVETT—9 General surgical operations  
 ROBERT H IVY—9 Oral and plastic surgery  
 GEORGE M BOYD—11 Operative gynecological clinic  
 WILLIAM H MACKINNEY—2 Genito urinary surgery  
 GEORGE M PIERSON—2 Ward rounds cardiorenal cases  
 GEORGE E PFÄHLER—2 Dry clinic Radiation and diagnosis of malignant diseases  
 ORLANDO H PETTY—4 Ward rounds diabetic cases

## METHODIST EPISCOPAL HOSPITAL

## Tuesday

OSAMON B PREIFFER and CALVIN M SMYTH, JR—9  
 General surgical operations

## Wednesday

JOHN C HIRST and LEONARD HAMBLOCK—9 Operative gynecology and obstetrics  
 JAMES H BALDWIN and WILLIAM R GILMOUR—9 General surgical operations

## Thursday

GEORGE SCHWARTZ—9 General surgical operations

## Friday

OSAMON B PREIFFER and CALVIN M SMYTH, JR—9  
 General surgical operations

## PRESBYTERIAN HOSPITAL

*Tuesday*

- E B HODGE and H P BROWN—9 General surgical operations  
A B GILL and T E ORR—2 Orthopedic operations

*Wednesday*

- D B PREIFFER—9 General surgical operations  
J S RODMAN—9 Dry clinic Surgical management of cranial injuries, abnormal involution of the breast  
A E BOTHE, J C BIRDSALL, I G HARRISON, H SAN CREE, H T KELLEY, S RAMIREZ, and W E UP CHURCH—2 Dry clinic Urological conditions in children, vesical neck obstruction, and results in the treatment of carcinoma of the bladder and prostate, pre and postoperative management of prostatic hypertrophy patients with diabetes hematoma, torsion of the testicle, Cantwell Young operation for epispadias present status of the disposition of the ureters in indicated cases, exhibition of patient having had bilateral nephrostomy performed 15 years previous

*Thursday*

- J H JOPSON and W E CHRISTIE—9 General surgical operations  
J H GIRVIN, G M LAWS, J P LEWIS and D RIEGEL—2 Dry clinic Treatment of myoma of uterus by operation, radium and X ray, value of pre operative cardiovascular study diathermy in gynecology, and results in treatment of prolapse of uterus, ureteral lesions, reduplication, stricture, calculi, exhibition of pathological material, lipectomy

*Friday*

- J SPEESE, T A BOTHE, J F SCHELL and G C GRIFFITH—9 Dry clinic End results in surgery on diabetic patients, end results in ileocecal obstructive lesions, end results in fractures of lower extremities treated by skeletal traction, pre and postoperative management of goiters, electrocardiographic studies in goiter cases, demonstration of closed method in treatment of empyema exhibition of cases of endoaneurysmorrhaphy, Kocher's tumor of the thyroid, carcinoma of thyroid, gangrene of leg treated by lumbar sympathectomy, fracture cases

## ST AGNES HOSPITAL

*Monday*

- WILBUR HAINES and F MICELI—2 Urological clinic

*Tuesday*

- E C MURPHY—9 General surgical clinic  
LEONARD AVERETT—10 Gynecological clinic

*Wednesday*

- J W BRANSFIELD—9 General surgical clinic  
G M DORRANCE—2 General surgery and cleft palate clinic  
WILBUR HAINES—2 Urological surgery

*Thursday*

- J F X JONES—9 General surgical clinic  
JOHN A MCGILLY—10 Gynecological clinic  
W W VAN DOLSEN—11 Obstetrical clinic

*Friday*

- G M DORRANCE—9 General surgical clinic  
WILBUR HAINES and F MICELI—2 Urological clinic

## COOPER HOSPITAL

(Camden)

*Tuesday*

- P M MCCRAY, A S ROSS, F W SHAVER, and I E DEIBERT—9 General surgical operations  
T B LEE, A B DAVIS, and G F WEST—9 Operative gynecology and obstetrics  
I E DEIBERT and R S GAMON—10 Fracture clinic

*Wednesday*

- P M MCCRAY, A S ROSS, F W SHAVER, and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
A H LIPPINCOTT and D F BENTLEY—2 Urological operations  
P M MCCRAY, A S ROSS, F W SHAVER, and I E DEIBERT—2 End results in fracture cases  
B F BUZBY—3 Demonstration of orthopedic cast and end results

*Thursday*

- P M MCCRAY, A S ROSS, F W SHAVER, and I E DEIBERT—9 General surgical operations  
T B LEE, A B DAVIS, and G F WEST—9 Operative gynecology and obstetrics  
A S ROSS—2 End results in industrial injuries (New Jersey State Clinic)

*Friday*

- P M MCCRAY, A S ROSS, F W SHAVER, and I E DEIBERT—9 General surgical operations  
B F BUZBY—9 Operative orthopedics  
I E DEIBERT and R S GAMON—10 Fracture clinic

## MISERICORDIA HOSPITAL

*Tuesday*

- J A KELLY and B R BELTRAN—9 General surgical operations  
F MOGAVRO—11 Pre and postoperative care, discussion of technique, postoperative complications and their treatment

*Wednesday*

- G P MULLER and T RYAN—9 General surgical operations  
DR DOUGHERTY—11 Fractures of the femur, presentation of Russell extension with revised apparatus, function of knee joint after healing of fracture

*Thursday*

- J A KELLY and B R BELTRAN—9 General surgical operations  
J A SHARKEY and D C GEIST—11 Blood transfusion, end results in operative fractures

*Friday*

- G P MULLER and T RYAN—9 General surgical operations  
J B CARRONE and E J GARVIN—11 Method of conducting general surgical clinic and demonstration of patients

## ST CHRISTOPHER'S HOSPITAL

*Tuesday*

- Staff—10 General surgery

*Friday*

- R L JOHN—10 Orthopedics



## HAHNEMANN HOSPITAL

## Monday

H P LEOPOLD—2 Hernia clinic  
D B JAMES and staff—2 Operative gynecology

## Tuesday

A B WEBSTER—0 Fracture clinic  
L T ASHCRAFT and staff—2 Genito urinary surgery

## Wednesday

L T ASHCRAFT and FRANK BENSON—9 Neoplasms of the genito urinary tract  
JOHN F JAMES and LEON CLEMENS—2 Obstetrical clinic, operations and demonstration of cases  
H L NORTHRUP—2 General surgical clinic

## Thursday

J DEAN ELLIOTT and WILLIAM SYLVIS—9 General surgical clinic  
D B JAMES and EARL B CRAIG—9 Operative gynecology  
JOHN A BROOKE and staff—2 Dry clinic, orthopedic surgery

## Friday

H L NORTHRUP and staff—9 General surgical clinic  
FRANK BENSON—9 Indications for radium treatment

## ST LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

## Tuesday

A B WEBSTER—0 Surgical clinic  
WARREN C MERCER and staff—9 Obstetrical clinic

## Wednesday

HERBERT P LEOPOLD and staff—9 Surgical clinic  
WILLIAM C HUNSICKER and staff—9 Urological clinic

## Thursday

H K ROESSLER—0 Surgical clinic  
RICHARD W LARKER, JOHN A BROOKE and staff—9 Orthopedic clinic

JAMES D SCHOFIELD and staff—9 Clinic on diseases of the rectum

WESTON D BAYLEY and associates—2 Neurosurgical symposium on injuries of the head

FRANK C BENSON and staff—2 Dry clinic Indications and contra indications for use of radium in myopathic hemorrhage

G MORRIS GOLDEN and group—2 Dry clinic and symposium on pre and postoperative problems of toxic goiter

## STETSON HOSPITAL

## Monday

CARL F KOENIG—1 30 Fracture clinic X ray demonstration

## Tuesday

WILLIAM T ELLIS and JOHN A BOGER—12 General surgery

## Wednesday

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 Pyelography uroselectan

## Friday

STEPHEN E TRACY—8 30 Gynecology  
CARL F KOENIG—1 30 X ray demonstration deep therapy results

## JEFFERSON HOSPITAL

## Tuesday

P BROOKE BLAND and staff—9 Gynecology and obstetrics

J TORRANCE RUGH and staff—10 Orthopedics  
J CHALMERS DA COSTA and staff—11 General surgery  
THOMAS C STELLWAGEN and staff—11 Genito-urinary surgery

JOHN H GIBSON and staff—2 General surgery

## Wednesday

BROOKE M ANSPACH and staff—9 Gynecology  
P BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C STELLWAGEN and staff—11 Genito-urinary surgery

J CHALMERS DA COSTA and staff—2 General surgery

## Thursday

P BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C STELLWAGEN and staff—10 Genito-urinary surgery

J CHALMERS DA COSTA and staff—11 General surgery  
J TORRANCE RUGH and staff—11 Orthopedic surgery  
I BROOKE BLAND and staff—4 Obstetrics

## Friday

BROOKE M ANSPACH and staff—9 Gynecology  
P BROOKE BLAND and staff—9 Gynecology and obstetrics

THOMAS C STELLWAGEN and staff—11 Genito-urinary surgery

JOHN H GIBSON—11 General surgery

## WOMAN'S MEDICAL COLLEGE HOSPITAL

## Tuesday

HUBLEY R OWEN—9 General surgery

## Wednesday

MARGARET C STURGIS—9 Demonstration of the use of carbon dioxide tubal insufflation and uterosalpingograms in the diagnosis of sterility

## Thursday

CATHARINE MACFARLANE—9 Gynecological clinic  
LIDA S COGILL—2 Obstetrical demonstration

## Friday

JOHN S RODMAN—9 General surgery

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

## Tuesday

JOHN DEAN ELLIOTT, T C GEARY and THOMAS DOYLE—9 General surgical clinic

LEON T ASHCRAFT—2 Urological surgery

## Wednesday

JOHN A BROOKE—2 Orthopedic surgery

## Thursday

NATHANIEL F LANE—2 Gynecological clinic  
NEWLIN F PAXSON—2 Lipiodol study of fallopian tubes

## Friday

WARREN C MERCER—2 Postnatal clinic

## PHILADELPHIA GENERAL HOSPITAL

*Monday*

WALTER E. ELMER—2 Orthopedic surgery

*Tuesday*

M. P. WARMUTH—9 General surgery

FRANK C. HAMMOND—11 Gynecology and obstetrics

*Wednesday*

J. T. RUGH—9 Orthopedic surgery

HUBLEY OWEN—2 General surgery

*Thursday*

E. A. SCHUMANN—9 Gynecology and obstetrics

W. H. MACKINNEY—2 Genito urinary surgery

*Friday*

HARVEY RICHTER—11 General surgery

JOHN O. BOWER—2 General surgery

## ST MARY'S HOSPITAL

*Tuesday*

JAMES A. KELLY—9 General surgery

WILLIAM J. RYAN—9 General surgery

WILLIAM E. PARKE—1 Obstetrical clinic

*Wednesday*

A. P. KEEGAN—9 General surgery

WILLIAM MORRISON—9 Gynecology

*Thursday*

HENRY K. SEELAUS—9 General surgery

JOSEPH TOLAND—9 Gynecology

J. STUART LAWRENCE—1 Obstetrical clinic

*Friday*

P. A. MCCARTHY—9 General surgery

LEO WOJCZYNSKI—9 Gynecology

## PENNSYLVANIA HOSPITAL

(Maternity Department and Lying In Hospital)

*Tuesday*

N. W. VAUX and staff—9 Obstetrics and gynecology

*Wednesday*

E. B. PIPER and staff—9 Obstetrics and gynecology

*Thursday*

N. W. VAUX and staff—9 Obstetrics and gynecology

*Friday*

E. B. PIPER and staff—9 Obstetrics and gynecology

## FRANKFORD HOSPITAL

*Tuesday*

C. F. NASSAU, L. D. ENGLERTH and B. CHANDLER—9 General surgery

*Wednesday*

EDWARD SCHUMANN and FREDERICK KELLER—9 Gynecological clinic

*Thursday*

W. E. PARKE—9 Gynecological clinic

GEORGE HANNA—9 Obstetrical clinic

L. D. ENGLERTH and B. CHANDLER—2 Fracture clinic

## ST JOSEPH'S HOSPITAL

*Monday*

FRANCIS J. McCULLOUGH—3 Obstetrical operations

*Tuesday*

MELVIN M. FRANKLIN—9 Fractures in children

F. HURST MAIER—10 Gynecological operations

ALEXANDER E. BURLE—11 Gynecological operations

*Wednesday*

JAMES A. KELLY—9 General surgical operations

JOHN F. X. JONES—9 General surgical operations

*Thursday*

ALEXANDER E. BURKE—8 Gynecological operations

F. HURST MAIER—10 Gynecological operations

CHARLES F. NASSAU—10 General surgical operations

*Friday*

MELVIN M. FRANKLIN—9 Surgery of children

FRANCIS J. McCULLOUGH—3 Obstetrical operations

## CHESTNUT HILL HOSPITAL

*Tuesday*

JOHN McCLOSKEY—10 30 General surgical clinic

E. A. SCHUMANN, DRs. BARRETT and TOWSON—11 Operative obstetrics

*Wednesday*

W. B. SWARTLEY and S. DANA WEEDE—9 30 General surgery

*Thursday*

CHARLES BEHNEY and FRANK PAYNE—9 Operative gynecology

ALEXANDER RANDALL and F. SCHOFIELD—9 Urological clinic

*Friday*

W. C. SICEHAN and L. HERGESHEIMER—9 General surgery

E. A. SCHUMANN, DRs. BARRETT and TOWSON—11 Operative obstetrics

## MT SINAI HOSPITAL

*Monday*

MOSES BEHREND—1 15 General surgical operations

*Tuesday*

BENJAMIN LIPSHUTZ—9 General surgical operations

ALEXANDER RANDALL—1 30 Urological clinic, operations and demonstration of cases

*Wednesday*

CHARLES MAZER—9 Operative gynecology

MORRIS COOPERMAN—2 Orthopedic clinic, operations and demonstration of cases

*Thursday*

BERNARD MANN—9 Operative gynecology

ALEXANDER RANDALL—1 30 Urological clinic, operations and demonstration of cases

*Friday*

BENJAMIN LIPSHUTZ—9 General surgical operations and demonstration of cases

MOSES BEHREND—1 General surgical operations and demonstration of cases

## NORTHWESTERN GENERAL HOSPITAL

## Tuesday

J B MENCKE, ROBERT BOYER and E B PARKER—9  
General surgical operations  
ARTHUR D KURTZ—2 30 Orthopedic clinic

## Wednesday

J B MENCKE, ROBERT BOYER and E B PARKER—9  
General surgical operations  
J S RAUDENBUSH—12 Gynecology  
L C DAVIS—3 Rectal clinic

## Thursday

J B MENCKE, ROBERT BOYER and F B PARKER—9  
General surgical operations  
I F MILLIKEN—2 30 Genito urinary surgery

## CHILDREN'S HOSPITAL

WALTER FSTELL LEE Surgical clinic  
WILLIAM A JAQUETTE Dental clinic  
HOWARD CHILDS CARPENTER Preventive medicine in  
reference to surgical diseases in children  
SUSAN C FRANCIS R N Hospital management from  
surgical viewpoint  
J C GRIFFITHS Medical aspect of surgical cases in chil-  
dren  
RALPH S BROWER Roentgenological aspect of children's  
diseases  
EDWARD F CORSON Bone syphilis and other allied sur-  
gical conditions  
C C NORRIS Vaginitis clinic

## JEWISH HOSPITAL

## Tuesday

J WALKER—9 Operative obstetrics and gynecology  
W H TELLER—2 General surgical operations

## Wednesday

F B BLOCH—9 General surgical operations  
J B LOWES—2 Urological surgery  
I BRINKMAN—2 General surgical operations

## Thursday

M BEHREND V LOEB M SEGAL and M WINSTON—9  
General surgical operations

## Friday

P F WILLIAMS—9 30 Operative gynecology  
C J STAMM—10 Operative gynecology  
W H TELLER—2 General surgical operations

## KENSINGTON HOSPITAL FOR WOMEN

## Tuesday

WILLIAM E PARKE—11 Prenatal clinic  
H C DEEVER—12 General surgery

## Wednesday

WILLIAM E PARKE—10 General surgery  
JOHN B HAINES—3 30 Cystoscopic clinic

## WOMAN'S HOMEOPATHIC HOSPITAL

## Tuesday

FRANCIS L HUGHES—9 Gynecological clinic

## Wednesday

ARTHUR HARTLEY—9 General surgical clinic

## EPISCOPAL HOSPITAL

## Monday

H C DEEVER—1 30 General surgical clinic

## Tuesday

LOUIS H MUTHCHLER—11 30 General surgical clinic  
JOHN B HAINES—2 Urological clinic  
TEMPLE FAY—2 Neurosurgical clinic

## Wednesday

A P C ASHURST—9 General surgical clinic  
R L JOHN—1 30 Orthopedic clinic  
R S BROWER—2 X ray demonstration

## Thursday

ROBERT H IRY—9 Oral surgery  
H C DEEVER—1 30 General surgical clinic

## Friday

LOUIS H MUTHCHLER—11 30 General surgical clinic  
JOHN B HAINES—2 Urological clinic

## NORTHEASTERN HOSPITAL

## Tuesday

I C DAVIS—2 Proctology  
T T THOMAS—3 Dry clinic Fractures and dislocations  
of the extremities methods of reduction and fixation  
in various typical fractures with X ray films taken  
before and after reduction, after treatment late re-  
sults

## Wednesday

J B LOWES—4 Genito urinary surgery

## Thursday

J S RAUDENBUSH—2 Gynecology and obstetrics  
I T THOMAS—3 Axillary operation for recurrent dis-  
location of the shoulder

## BABIES HOSPITAL

## Tuesday

JOHN SINCLAIR and WILLIAM BATES—2 30 Presentation  
of follow up cases of intussusception and congenital  
hypertrophic stenosis

## Thursday

JOHN SINCLAIR and I BINDER—2 30 Conservative treat-  
ment of cervical adenitis

## JEAN'S HOSPITAL

## Wednesday

ROSCOE W TEAHAN—2 Carcinoma of skin  
CLARENCE A WHITCOMB—2 Lung tumors and mediastinal  
masses  
I WOOD E DOWNS—2 The saturation method of X ray  
treatment  
WILLARD S HASTINGS—2 Exhibition of interesting  
pathological specimens

## WOMAN'S HOSPITAL

## Tuesday

EMILY W AUGER—9 General surgery

## Wednesday

DOROTHY C BLECHSCHMIDT—9 General surgery  
FAITH S FETTERMAN—9 Cystoscopic demonstration

## Friday

MARIE FORMAN—9 Gynecological clinic

## ORTHOPEDIC HOSPITAL

*Tuesday*

A P C ASHURST, R L JOHN and E T CROGAN—I  
Out patient clinic  
A B GILL—9 Orthopedic operations

*Thursday*

A P C ASHURST and staff—9 Orthopedic operations  
WILLIAM J TAYLOR—I Out patient clinic

*Friday*

WILLIAM J TAYLOR—I Orthopedic operations

## AMERICAN ONCOLOGIC HOSPITAL

*Tuesday*

ALBERT E BOTHE, CHARLES C CODMAN, GEORGE M DORRANCE, WILLIAM C HUTNER, BRADY A HUGHES, C B LONGENECKER, SAMUEL MCCLARY III, ELLICE McDONALD, WILLIAM S NEWCOMET, DAMON B PFEIFFER, WILLIAM D ROBINSON, JESSE W SMITH, WILLIAM H SPENCER and S E TRACY—9 Clinical conference with exhibition of patients Fibroid tumors, breast cases, congenital mouth cases, hemangiomas, etc

## PENNSYLVANIA HOSPITAL

*Tuesday*

CHARLES F MITCHELL and associates—9 Surgical clinic

*Wednesday*

JOHN H GIBBON and associates—9 Surgical clinic

*Thursday*

CHARLES F MITCHELL and associates—9 Surgical clinic

*Friday*

JOHN H GIBBON and associates—9 Surgical clinic

## EVANS DENTAL INSTITUTE

*Tuesday*

ROBERT H IVY—9 Fracture of the jaw

*Wednesday*

LAWRENCE CURTIS—9 Oral surgical clinic

*Thursday*

ROBERT H IVY and LAWRENCE CURTIS—9 Oral surgical clinic

## SURGERY OF THE EYE, EAR, NOSE AND THROAT

## CLINICAL DEMONSTRATIONS

(Ballroom, Bellevue Stratford Hotel)

*Tuesday, 9 a m*

Indications for and Technique of the Different Operations for Chronic Mastoiditis (lantern slide demonstration)  
J MORRISSE SMITH, M D New York  
Discussion J CLARENCE KELLER, M D, Philadelphia

Chronic Suppurative Otitis Media GEORGE L TOBEY, M D, Boston

Discussion GEORGE M COATES, M D, Philadelphia  
What Place Have Operative Procedures in Otolaryngology? JOHN F BARNHILL, M D Indianapolis

Discussion GEORGE B WOOD, M D, Philadelphia  
Preparation for Ophthalmic Practice EDWARD JACKSON, M D, Denver

Discussion T B HOLLOWAY, M D, Philadelphia

*Wednesday, 9 a m*

Practical Application of Bacteriology to Clinical Ophthalmology S HANFORD MCKEE, M D, Montreal

Discussion JOHN A KOLMER M D, Philadelphia  
Cataract Extraction, a Study of Details WALTER B LANCASTER, M D, Boston

Cataract Extraction (moving picture demonstration)  
FRANK PARKER, M D, Norristown, Pa

Discussion EUGENE M BLAKE, M D, New Haven, Conn., and LUTHER C PETER, M D Philadelphia

Some Factors Concerned in the Success of Operations for Glaucoma JONAS FRIEDENWALD, M D, Baltimore  
Discussion WILLIAM ZENTMAYER, M D, and FRANCIS H ADLER, M D, Philadelphia

*Thursday 9 a m*

Plastic Facial Work VILRAY P BLAIR, M D, St Louis  
Discussion ROBERT H IVY, M D Philadelphia

Rare Types of Carcinoma and Conditions Simulating Carcinoma (lantern slide demonstration) JOHN E MACKENTY, M D, New York

Early Diagnosis and Treatment of Malignancy of the Laryngopharynx HENRY BOYLAN ORTON, M D, Newark, N J

Discussion FIELDING O LEWIS, M D, Philadelphia  
Treatment of Tic Douloureux and Ménière's Disease  
WALTER L DANDY, M D, Baltimore  
Discussion FRANCIS C GRANT, M D, Philadelphia

*Friday, 9 a m*

Symposium on Sinus Thrombosis

Rhinological Aspects E ROSS FAULKNER, M D, New York

Otological Aspects WELLS P EAGLETON, M D, Newark, N J

Ophthalmological Aspects W L BENEDICT, M D, Rochester, Minn

Discussion GEORGE M COATES, M D, RALPH BUTLER, M D, Philadelphia, and PROFESSOR EMILE v GROSZ, Budapest, Hungary

## EPISCOPAL HOSPITAL

*Monday*

FREDERICK KRAUSS—2 Eye clinic  
W R WATSON—2 Ear, nose and throat clinic

*Tuesday*

HAROLD VON GOLDBERG—2 Eye clinic

*Wednesday*

W R WATSON—I 30 Ear, nose and throat clinic  
A G FEWELL—3 Eye clinic

*Thursday*

C C BIEDERT—I 30 Ear, nose and throat clinic  
FREDERICK KRAUSS—I 30 Eye clinic

*Friday*

C C BIEDERT—I 30 Ear, nose and throat clinic  
HAROLD VON GOLDBERG—I 30 Eye clinic

## GRADUATE HOSPITAL

*Monday*

L WEBSTER FOX—1 Operative eye clinic  
RALPH BUTLER—2 Nose and throat operations  
GEORGE M COATES—2 Operative ear clinic

*Tuesday*

ROSS HALL SKILLERN—2 Operative sinus clinic  
WALTER ROBERTS—2 Operative ear clinic  
WILLIAM ZENTMAYER—2 Operative eye clinic

*Wednesday*

E B GLEASON—2 Operative nose and throat clinic  
LUTHER C PETERS—2 30 Operative eye clinic  
GEORGE B WOOD—3 Operative nose and throat clinic

*Thursday*

GABRIEL TUCKER—9 Bronchoscopic clinic  
L WEBSTER FOX—1 Operative eye clinic  
RALPH BUTLER—2 Nose and throat operations  
GEORGE M COATES—2 Operative ear clinic

*Friday*

WALTER ROBERTS—2 Surgery of the ear  
ROSS HALL SKILLERN—2 Operative sinus clinic

## JEWISH HOSPITAL

*Monday*

A BRAV—2 Eye clinic  
H M GODDARD—2 Otolaryngological operations

*Wednesday*

J C KNIFE—3 Eye clinic

*Thursday*

A S KAUFMAN—2 Otolaryngological operations  
R F RIDPATH—3 Otolaryngological operations

## ST MARY'S HOSPITAL

*Tuesday*

WILLIAM GRADY—3 Otolaryngology

*Wednesday*

F A MURPHY—3 Ophthalmology

*Thursday*

R T M DONNELLY—3 Ophthalmology  
EDWARD MURPHY—3 Otolaryngology

## HAHNEMANN HOSPITAL

*Tuesday*

H S WEAVER and staff—2 Ear nose and throat clinic

*Thursday*

H S WEAVER and staff—2 Ear nose and throat clinic

*Friday*

FRANK NAGLE and FRED PETERS—9 Cataract operations

## ST AGNES HOSPITAL

*Tuesday*

BENJAMIN D PARISER—1 Ear, nose and throat clinic

*Wednesday*

GEORGE F J KELLY—2 30 Ophthalmological clinic

## WILLS EYE HOSPITAL

*Monday*

PAUL J PONTIUS J MILTON GRISCOM and THOMAS A  
O'BRIEN—2 Ophthalmological clinics operations and  
demonstration of cases

*Tuesday*

BURTON CHANCE FRANK C PARKER B F BAER and  
LEIGHTON F APPLEMAN—2 Ophthalmological clinics  
operations and demonstration of cases

*Wednesday*

PAUL J PONTIUS J MILTON GRISCOM and THOMAS A  
O'BRIEN—2 Ophthalmological clinics operations and  
demonstration of cases

*Thursday*

BURTON CHANCE, FRANK C PARKER B F BAER and  
LEIGHTON F APPLEMAN—2 Ophthalmological clinics  
operations and demonstration of cases

*Friday*

PAUL J PONTIUS, J MILTON GRISCOM and THOMAS A  
O'BRIEN—2 Ophthalmological clinics operations  
and demonstration of cases

## JEFFERSON HOSPITAL

*Tuesday*

LOUIS H CLERY and staff—9 Bronchoscopy  
F O LEWIS and staff—9 Nose and throat operations

*Wednesday*

F O LEWIS and staff—10 Carcinoma of larynx  
LOUIS H CLERY and staff—11 Bronchoscopy

*Thursday*

LOUIS H CLERY and staff—9 Bronchoscopy  
F O LEWIS and staff—9 Nose and throat operations

*Friday*

C F G SHANNON and staff—3 Ophthalmology

## MT SINAI HOSPITAL

*Monday*

C W LEFEVER—3 30 Eye clinic operations and demon-  
stration of cases

*Tuesday*

LEWIS FISHER—1 Ear nose and throat clinic operations  
and demonstration of cases

*Wednesday*

DAVID HUSIK—2 30 Ear, nose and throat clinic  
GABRIEL TUCKER—4 Bronchoscopy

*Thursday*

MORRIS WEINSTEIN—2 Ear nose and throat clinic, opera-  
tions and demonstration of cases

*Friday*

MATTHEW CRISLER—1 Ear, nose and throat clinic, opera-  
tions and demonstration of cases

## PHILADELPHIA GENERAL HOSPITAL

*Tuesday*

ROBERT J HUNTER—2 Laryngology

*Friday*

L WALLACE DECHLER—9 Ophthalmology

## TEMPLE UNIVERSITY HOSPITAL

*Monday*

MATTHEW ERSNER—3 Operative otology

*Tuesday*E L VAN LOON—8 30 Bronchoscopy and oesophagoscopy  
(Chevalier Jackson clinic)

ROBERT F RIDPATH—2 Laryngological clinic

*Wednesday*E L VAN LOON—8 30 Inspection of Chevalier Jackson  
bronchoscopic clinics*Thursday*E L VAN LOON—8 30 Inspection of Chevalier Jackson  
bronchoscopic clinics

ROBERT F RIDPATH—2 Operative laryngology

*Friday*E L VAN LOON—8 30 Oesophagoscopy and bronchoscopy  
(Chevalier Jackson clinic)

MATTHEW ERSNER—4 Otological clinic

## UNIVERSITY HOSPITAL

*Tuesday*

GABRIEL TUCKER—9 Bronchoscopic clinic

*Wednesday*GEORGE FETTEROLF and staff—2 Otolaryngological  
clinic, operations and demonstration of cases*Friday*GABRIEL TUCKER—9 Bronchoscopic clinic  
GEORGE FETTEROLF and staff—2 Otolaryngological  
clinic, operations and demonstration of cases  
T B HOLLOWAY—4 Ophthalmological clinic

## ST CHRISTOPHER'S HOSPITAL

*Monday*H J WILLIAMS or E H CAMPBELL—1 30 Nose and  
throat clinic*Wednesday*H J WILLIAMS or E H CAMPBELL—9 Nose and throat  
clinic*Thursday*

DR FELDMAN—10 Eye clinic

*Friday*H J WILLIAMS or E H CAMPBELL—1 30 Nose and  
throat clinic

## COOPER HOSPITAL

## (Camden)

*Tuesday*

A M ELWELL—2 Otolaryngological operations

*Wednesday*

J S SHIPMAN—3 Ophthalmological operations

*Thursday*

A M ELWELL—2 Otolaryngological operations

## ST JOSEPH'S HOSPITAL

*Tuesday*GEORGE MORLEY MARSHALL—9 The Marshall operation  
for nasal deformity with end results  
A J KEENAN—3 Otolaryngological operations*Wednesday*

ARTHUR WRIGLEY—9 Otolaryngological operations

*Thursday*GEORGE MORLEY MARSHALL—9 The radical mastoid  
with end results

C T MCCARTHY—2 Otolaryngological operations

*Friday*

FRANCIS V GOWEN—9 Otolaryngological operations

## LANKENAU HOSPITAL

*Monday*

W J CREIGHTON and DR SMITH—1 Eye Clinic

*Tuesday*W J CREIGHTON and DR SMITH—1 Eye clinic  
RALPH BUTLER and J A BABBITT—2 Ear, nose and  
throat clinic*Wednesday*

W J CREIGHTON and DR SMITH—1 Eye clinic

*Friday*

W J CREIGHTON and DR SMITH—1 Eye clinic

## MISERICORDIA HOSPITAL

*Monday*

J E LOFTUS—2 Otolaryngological operations

*Tuesday*

C T MCCARTHY—2 Otolaryngological operations

*Wednesday*

J E LOFTUS—2 Otolaryngological operations

*Thursday*

C T MCCARTHY—2 Otolaryngological operations

*Friday*

J E LOFTUS—2 Otolaryngological operations

## NORTHWESTERN GENERAL HOSPITAL

*Tuesday*M S ERSNER, H S WIEDER and M A ZACKS—2 Nose  
and throat clinic*Thursday*M S ERSNER, H S WIEDER and M A ZACKS—2 Nose  
and throat clinic  
S H BROWN—3 Eye clinic

## NORTHEASTERN HOSPITAL

*Wednesday*GEORGE E SHAFFER—2 Sinus disease  
G A LAWRENCE—3 Ophthalmology

## CHESTNUT HILL HOSPITAL

*Tuesday*

JOHN R. DAVIES—1 Ear, nose and throat clinic

*Wednesday*

BENJAMIN D. PARISH and DR. TRACANZI—1 30 Ear nose and throat clinic

*Thursday*JOHN R. DAVIES—1 Ear nose and throat clinic  
CARL WILLIAMS—2 Ophthalmology*Friday*

BENJAMIN PARISH—1 30 Ear nose and throat clinic

## WOMAN'S SOUTHERN HOMEOPATHIC HOSPITAL

*Thursday*GILBERT J. PALEN CARROLL HAYES H. BAILEY  
CHALFONT and EVERETT A. TYLER—2 Tonsillectomy and adenoidectomy clinic adults and children under gas anesthesia

## WOMAN'S MEDICAL COLLEGE HOSPITAL

*Tuesday*

MARGARET F. BUTLER—1 Ear nose and throat clinic

*Friday*

MARGARET F. BUTLER—1 Ear nose and throat clinic

## CHILDREN'S HOSPITAL

JAMES A. BABBITT and associates Nose and throat clinic  
EDWARD SHILWAY Eye clinic

## PRESBYTERIAN HOSPITAL

*Monday*

H. M. LANGDON and J. M. THORINGTON—2 Ophthalmology

*Friday*

N. P. STAUFFER W. L. CARISS and O. R. KLINE—2 Otolaryngological operations

## FRANKFORD HOSPITAL

*Tuesday*

FRANK EMBERY and ROBERT WATT—2 Ear nose and throat clinic

*Wednesday*WILLIAM H. CHANDLER—1 Eye clinic  
DR. RICHARDSON—2 Ear, nose and throat clinic

## STILTON HOSPITAL

*Thursday*

CARL LEE FELT—1 Ear, nose and throat clinic

## WOMAN'S HOMEOPATHIC HOSPITAL

*Thursday*

JOSEPH V. F. CLAY J. R. CRISWELL and CHARLES J. V. FRIES, JR.—9 Nose and throat clinic

## ST. LUKE'S AND CHILDREN'S HOMEOPATHIC HOSPITAL

*Tuesday*

CHARLES B. HOLLIS and staff—9 Ear nose and throat clinic







# SURGERY, GYNECOLOGY AND OBSTETRICS

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## HUMAN BITE INFECTIONS OF THE HAND

WITH A STUDY OF THE ROUTES OF EXTENSION OF INFECTION FROM THE DORSUM OF THE HAND<sup>1</sup>

MICHAEL L. MASON, M.D., F.A.C.S., AND SUMNER L. KOCH, M.D., F.A.C.S., CHICAGO

From the Department of Surgery Northwestern University Medical School

WITH the exception of furuncles and carbuncles on the dorsal surface of the hand and proximal phalanges there are no infections which so commonly involve these areas as those resulting from human teeth. Blastomycosis and sporotrichosis, if they involve the hand, usually affect the dorsal surface, but they are of infrequent occurrence. Although relatively few cases of bite infection have been reported in the literature—some thirty-five cases prior to 1910 and considerably fewer since that time—the fact that fist fights and broken knuckles are of such common occurrence leads one to conclude that such injuries have not received the attention or study they deserve particularly in view of the long continued infection and marked impairment of function that so often follow such injuries.

During the past three years we have had under our care thirteen patients suffering from

human bite infections. They have presented such a typical course that it is apparent that there are several factors present in such cases which combine to produce a unique chain of symptoms.

While in the cases reported in the literature emphasis has been placed on the symbiosis of the spirillum and fusiform organisms of Vincent, no mention is made of two other important factors—the exact site at which and the depth to which the infectious agent is introduced into the tissues, and the anatomical arrangement of the joint capsules and of the fascial layers of the dorsum of the hand—the predominant factor in determining the extension of infection from the site of primary involvement.

It is our purpose in this report to discuss the three factors which we believe are responsible for the clinical and pathological picture, to describe what we think is a fairly typical clinical course, and to discuss this clinical course in some detail, to outline a method of treatment and to report thirteen personally observed instances of this condition.

### RÉSUMÉ OF THE LITERATURE

Hultgen (1910) reported what he believed to be the first instance of "gangrenous peri-onychia" due to the symbiosis of fusiform bacillus and the spirochæta denticola. His

Fig. 8 Cross sections of hand 4. In A in the region of the metacarpophalangeal joints considerable infiltration has occurred and the material has extended volarward along the interosseus and lumbrical muscles. Dorsally the subaponeurotic and subfascial spaces have been invaded. In B very extensive distribution is seen both on the volar and dorsal surfaces. The mass lies on the volar surface of the adductor pollicis muscle separated from the thenar space only by the fascia overlying the muscle. C a section taken through the bases of the metacarpals shows the mass lying in the two dorsal spaces of the hand and in the substance of the first interosseus muscle.

The anatomical material used for experimental injections was given by the Department of Anatomy and the roentgenograms of the injected hands were made by the Department of Roentgenology of Northwestern University Medical School.

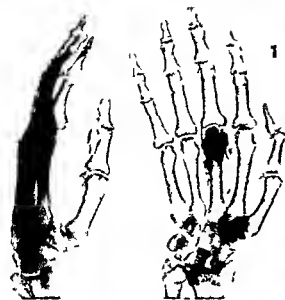


Fig 1 Anteroposterior and lateral roentgenograms of hand 1. The mass has filled the joint cavity, has broken through the joint capsule and spread proximally under the dorsal aponeurosis. The curved tract left by the needle is well shown in the lateral picture.



Fig 2 Roentgenograms of hand 2. The mass injected into the third metacarpophalangeal joint has ruptured from the joint and extended distalward in subfascial spaces of index, middle and ring fingers and proximalward over the metacarpus in the subaponeurotic space.

patient was a girl of 7, who infected her left index finger by biting her nails. Smears from the girl's teeth showed the same organisms as were found in the infected finger.

Peters (1911) reported two cases of hand infection due to injuries from human teeth. In each instance the patient had struck another person on the mouth and suffered a wound from the opponent's teeth. He noted the intense swelling and edema and the foul discharge which followed these injuries, and in a patient who refused operation noted the development of the purplish, ragged, irregular granulations. In one case smears yielded the bacillus fusiformis and streptococcus. In the other the typical fusiform spirillum combination was obtained.

Hennessey, Madras and Fletcher (1920) studied carefully an instance of mouth bite infection and noted the mild systemic reaction associated with it. In this case the organisms of Vincent's angina were also found.

Pilot and Meyer (1925) at the Cook County Hospital, Chicago, treated a negro who was bitten on the left middle finger. A deep ulcer developed at the site of injury. The surface was moist, dark and green, with necrotic bone

in the center. The margins were irregular, shaggy and bleeding, and a putrid purulent discharge was present. There was moderate fever. A roentgenogram of the finger revealed a ragged periosteum and a solution of continuity of the bone resembling a fracture. Smears from the wound yielded fusiform bacilli, spirilla, and a mixture of streptococci and diphtheroid organisms. The finger was amputated through the middle phalanx and neo arsphenamin administered intravenously. The tissue removed showed deep infiltration with plasma cells, lymphocytes and many eosinophils, there were few polymorphonuclear leucocytes.

Fuller and Cottrell (1927) reported a case somewhat similar to that of Pilot and Meyer.

II R Owen (1928) reported the case of a police officer who developed a chancre of the hand following a bite by a prisoner. Owen remarked that while this was an uncommon complication of such injuries it had occurred in the experience of many surgeons.

John B. Hick reported a case of "gangrenous infection of the hand following human bite" before the Philadelphia Academy of Surgery in 1929. The patient, a negro, 30 years of age, was bitten on the right thumb some five days previous to admission to the





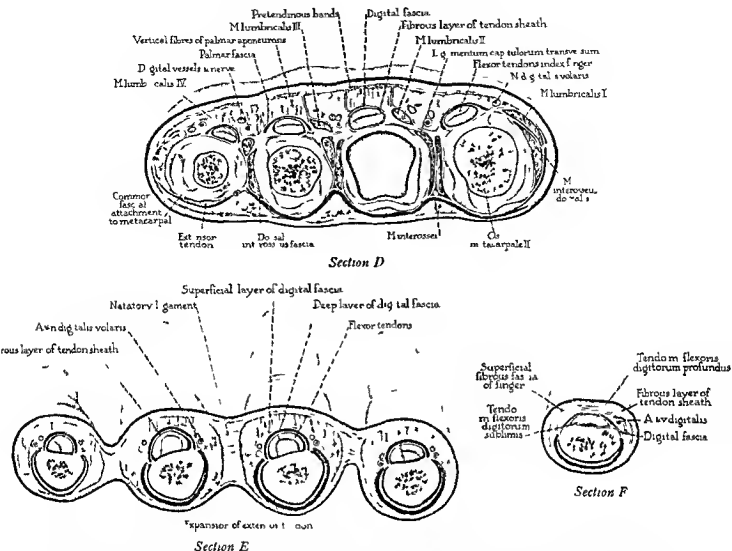


Fig. 4. Cross sections of hand. Section A through the bases of the metacarpals shows the mass entirely under the aponeurosis but confined to the region over the third and fourth metacarpals. Section B taken just proximal to the midline between the heads and bases of the metacarpals, shows the material spread widely under the aponeurosis. In section C, slightly distal to the preceding one, some of

the barium is seen to lie superficial to the dorsal tendon. In the region of the metacarpophalangeal joints the barium lies within the joint space and has spread distalward over the superficial surface of the extensor tendon in the dorsal subfascial space. From this region it has spread distalward still in the subfascial space into the fingers (Sections E, F).

into a fist, with the skin and extensor tendons stretched tightly across the joint, comes into contact with the tooth, which usually penetrates the joint cavity. Due to the flexed position of the fingers the infectious agent is introduced at a point proximal to the attachment of the tendon to the joint capsule. When the finger is extended the original line of entrance is sealed off by the skin and tendon as they glide proximalward. This mechanism is illustrated in the lateral roentgenogram of experimental hand 1 (Fig. 1). The infectious agent is at once introduced into three spaces—the joint space, the dorsal subcutaneous

space, and the dorsal subaponeurotic or sub-tendinous space between the tendon and the capsule, where a subtendinous bursa is usually found. At times the tooth injury is received over the proximal phalanx of the finger, in which case infectious organisms may be deposited both superficial to and under the expansion of the extensor tendon on the finger. Less frequently (Case 7) the injury involves the space on the dorsum between the heads of two metacarpals. In such a case the infectious process develops in a loose areolar space in potential communication with any of the other fascial spaces of the hand. With actual

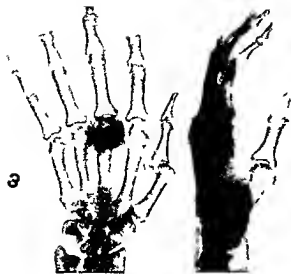


Fig. 5 Roentgenogram of hand 3. The material injected into the third metacarpophalangeal joint has slightly invaded the subtendinous bursa.



Fig. 6 A longitudinal section through hand 3 shows that the metacarpophalangeal joint is filled with the barium mass, which has broken through the capsule dorsally and infiltrated the region of the subtendinous bursa.



Fig. 7 Roentgenogram of hand 4. The barium mixture was injected into the metacarpophalangeal joint of the index finger and the needle then thrust farther volarward. There has been a tremendous infiltration of all the tissues.



Fig. 9 Roentgenogram of hand 5. The barium was injected into the subaponeurotic space on the proximal phalanx of the ring finger and has extended both proximal ward and distal ward.

bite wounds the infection may enter at any location (Cases 7, 9 and 11).

After gaining entrance into the subcutaneous tissues, extension of the infection is determined by the anatomical arrangement of the tissues. The spread, however, is not entirely determined by the continuity of one fascial space with another, but also by the involvement in the process of thin fascial sheets which when infected lead to extension throughout the spaces of which they form the covering.

Dissections of the hand with especial attention to the region of the metacarpophalangeal joints, show that in this region there is a convergence of vessels, tendons and fascia which come from both the volar and dorsal surfaces. The anatomy of the joint capsule itself is also of importance.





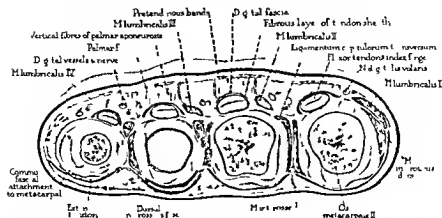


Fig. 12. Cross section of hand 6 through the region of the metacarpophalangeal joint. The fourth metacarpophalangeal joint is filled with the mixture which also lies in the bursa under the tendon as well as dorsal to the tendon because of leakage about the needle tract.

#### ANATOMY OF THE FASCIA ABOUT THE METACARPOPHALANGEAL JOINTS

The arrangement of the fascia about the metacarpophalangeal joints is rather complex since most of the layers of the fascia of the hand have some attachment at this location. Under the skin of the dorsum of the hand there is loose areolar, subcutaneous tissue which separates it from the dorsal subcutane-

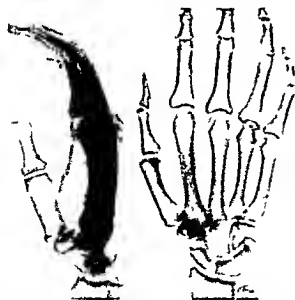


Fig. 14. Roentgenograms of hand 6. In the antero-posterior view the material is seen to overshadow the fourth metacarpophalangeal joint and the head of the fourth metacarpal bone. In the lateral view the mass fills the subtendinous bursa.



Fig. 15, 13. Roentgenogram of hand 7. The mass appears partially to encircle the proximal phalanx and spreads out slightly proximally. The joint is free while on the finger soft tissues appear to be interposed between a deeper accumulation of barium lying close to the bone and a more superficial accumulation.

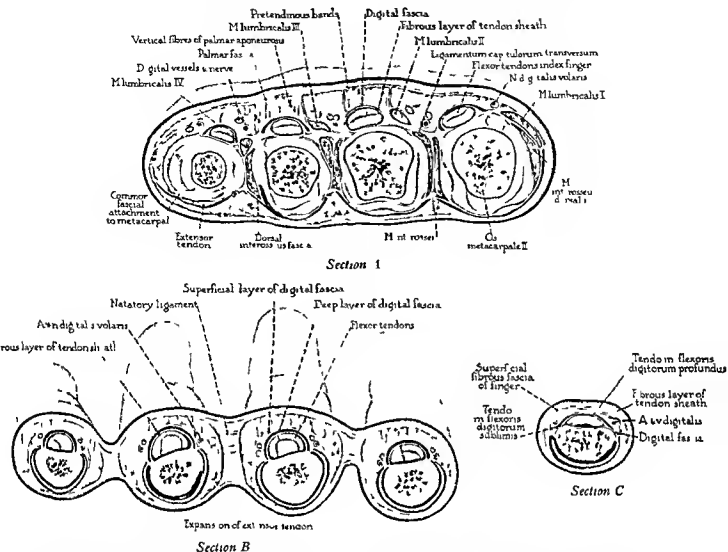


Fig 14 Cross sections of hand 7 A, Section through the region of the metacarpophalangeal joints B, Section through the bases of the proximal phalanges C, Section through the distal one half of the proximal phalanx

ous fascia. The dorsal subcutaneous fascia covers the back of the hand and has very loose attachments to the underlying dorsal tendons, but it is attached to the skin so that the two structures, skin and fascia, move together. This fascial layer passes distally over the metacarpophalangeal joints on to the fingers, where it becomes continuous with the superficial layer of the digital fascia. At the clefts between the fingers the fascia dips volarward to become continuous with the superficial layer of the palmar fascia, which itself is continuous with the distal portion of the palmar aponeurosis.

There is a second layer of fascia over the fingers, the deep digital fascia, which is attached laterally to the sides of the phalanges. On the volar surface this fascia splits into

two layers on either side to enclose the digital vessels and nerves. Dorsally this layer forms a covering for the extensor tendon, and appears to end in the region of the metacarpophalangeal joints by becoming attached to the superficial dorsal fascia. In the region of the digital clefts the deep digital fascia becomes attached to the dorsal interosseous fascia and to the sheets of fascia which pass between the interosseous muscles.

There are certain differences between the three fascial spaces which are found upon the dorsum of the fingers. The superficial fibrous fascia of the finger is closely connected to the skin by short perpendicular trabeculae which make a fairly dense area in which the spread of infection is limited. The superficial digital and deep digital fascia are also bound to each



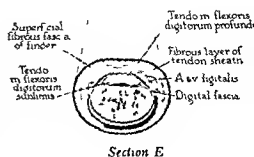
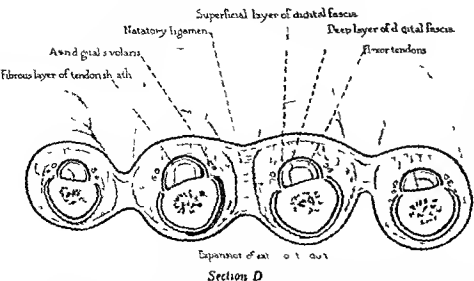


Fig 15 Cross sections of hand 8 A Section near the bases of the metacarpals B Section through the middle of the metacarpus C, Section through the metacarpophalangeal joints D, Section through the bases of the proximal phalanges E, Section through the middle of the proximal phalanx of the ring finger

other, though somewhat less securely, so that spread of infectious material between them is somewhat limited. Between the deep digital fascia and the tendon, however is very loose

areolar tissue which allows freedom of movement of the tendon. Infection in this space spreads much more easily than in the more superficial space and the infectious material is directed by the fascia around the phalanx toward the volar surface, where it comes to lie against the neurovascular tunnel leading into the palm. The extensor tendon over the proximal phalanx receives the attachments of the lumbrical and interossei muscles



Fig 16 Roentgenogram of hand 8. The mass was injected into the cleft between the middle and ring fingers and has spread both proximally and distally

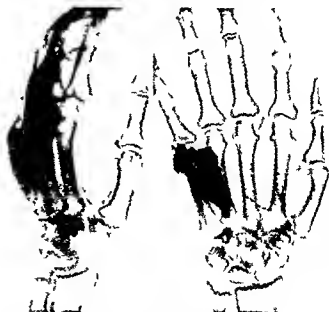


Fig 17 Roentgenogram of hand 9. The mass was injected under the extensor aponeurosis over the fifth metacarpophalangeal joint. A considerable amount was injected but none has spread radial to the midline of the fourth metacarpal bone



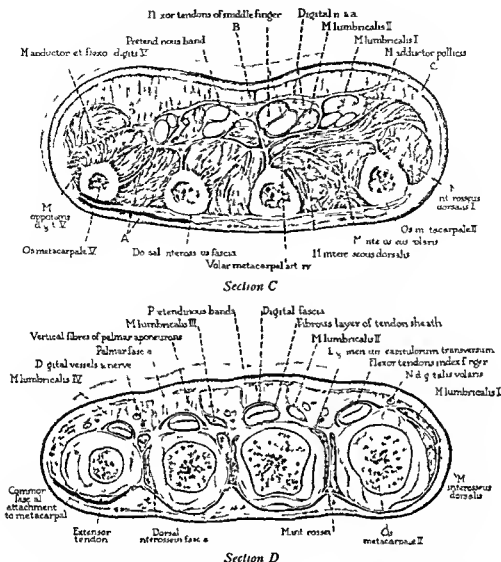


Fig. 18 Cross sections of hand of A, Section through the bases of the metacarpals B, Section just proximal to the middle of the metacarpus C Section just distal to the middle of the metacarpus D, Section through the metacarpophalangeal joints

proximal to the capsular attachment of the extensor tendon and usually contains a subtendinous bursa which permits easy motion of the tendon over the head of the metacarpal bone. This bursa overlies the dorsal part of the joint capsule which in this location is quite thin.

The attachment of the tendon to the metacarpophalangeal joint is of more than theoretical interest. When the joint is flexed, as the fist is closed, the attachment is carried distally so that the knuckles are covered by the extensor tendon and subtendinous bursa proximal to the joint attachment of the tendon. Anything introduced into the subtendinous space while the hand is made into a fist must enter the proximal compartment of the dorsal

subtendinous space. This space is of considerable extent and extends proximally over the metacarpus.

The attachments of the capsule of the metacarpophalangeal joints are fairly well known but their importance in the extension of purulent exudate from the joint into the surrounding structures has not been emphasized. The capsule of the joint is lined by an inner synovial layer of fine and thin texture. Surrounding this layer is a thicker sheet of fibrous tissue which is condensed into various thickened portions so as to strengthen the joint. On the anterior or volar surface of the joint there is a dense, tough fibrous plate almost as hard as cartilage, in which masses of cartilage may at times be found.

This plate is further thickened by the addition of fibers from the fibrous sheaths of the flexor tendons. Laterally there are developed in the fibrous capsule on either side thick bands, the collateral ligaments, which run from the nodules on the dorsal surface of the heads of each metacarpal bone, distally and volarward to become attached to the lateral surfaces of the condyles of the base of the first phalanx. A less definite ligament, the volar accessory ligament, runs from the dorsal part of the capsule to the thick volar plate. There are four definite weak spots in the joint capsule, which make for greater mobility of the joint. All of them are in relation to the metacarpal attachments of the joint capsule. One lies on the volar surface at the proximal border of the dense volar plate which is securely attached to the proximal phalanx but attached to the metacarpal bone by only a thin, redundant synovial sheet. When the joint is extended, and when the joint cavity is distended the loose attachment of the capsule becomes apparent as a thin membrane covering over the condyles of the metacarpal bone. There are two other weak spots in the joint capsule between the contiguous borders of the collateral ligaments and the accessory ligaments. A fourth and very important one lies under the extensor tendon directly over the head of the metacarpal and between the points of attachment of the collateral ligaments. It may communicate directly with the thin walled bursa which lies under the extensor tendon just proximal to the head of the metacarpal bone.

The relations of the joint to the surrounding structures are as follows. Dorsally lies the extensor tendon which at this place is considerably thicker than anywhere else in its course and is separated from the capsule by the subtendinous bursa. The capsule proper on the dorsum of the joint consists only of a thin synovial membrane, and the fibers of insertion of the extensor tendon. Between the surface of the cartilage covered head of the metacarpal bone and the skin are the following structures: (1) The synovial capsule, (2) the posterior or proximal subtendinous space with the subtendinous bursa, (3) the attachment of the tendon into the joint capsule, (4) the distal

compartment of the subaponeurotic or sub-tendinous space, (5) the extensor tendon, (6) the dorsal subfascial space, (7) the dorsal fascia, (8) the subcutaneous tissues, (9) the skin.

Lateral to the joint the dorsal fascia dips down into the spaces between the heads of the metacarpal bones and becomes attached to the dorsal interosseous fascia. Between the heads of the bones over the lateral aspect of the joints, the dorsal fascia is quite thin. Under it lies the dorsal aponeurosis which is the expansion of the extensor tendons. At this point it is receiving the attachments of the interosseous muscles, and this tendinous sheet lies directly over the joint and covers over the weak spot in the lateral capsule of the joint between the collateral and volar accessory ligaments. Between the dorsal aponeurosis and the joint capsule there is a thin layer of fibrous tissue. The line of attachment of the extensor tendon to the capsule turns volarward over the lateral side of the joint and is reflected proximally so that the thinner portion of the capsule between the two lateral ligaments lies in the distal sub-tendinous compartment.

The volar portion of the joint capsule is the dense plate mentioned above. To its sides are attached the transverse metacarpal ligaments which hold the adjacent metacarpal heads together. Volar to the transverse metacarpal ligaments run the lumbrical tendons to the fingers. On the volar surfaces of the dense volar plate of the joint capsule lie the flexor tendons in their fibrous and synovial sheaths. The volar plate is continued proximally over the head of the metacarpal bone and becomes continuous with the volar interosseous fascia over the bone and interosseous muscles. It is not firmly attached to the head of the metacarpal bone, though a thin sheet of tissue passes from its under surface to the metacarpal. This sheet is lined on its joint surface by synovial membrane and allows free movement of the joints.

In order to test experimentally the significance of the anatomical relationships about the metacarpophalangeal joints a series of injections were made of cadaver hands after the manner of the classical experiments

undertaken by Kanavel to determine the routes of extension of infection from the subcutaneous tissues, the flexor tendon sheaths, and the various fascial spaces of the hand. Barium sulphate was thoroughly dissolved in a warm, fairly thick solution of gelatin in water. While still warm and very fluid this mass was injected under pressure into the regions most often the site of human bite injury. Most of the injections were made, therefore, into the metacarpophalangeal joints, one was made over the dorsum of the proximal phalanx and one in the cleft between two fingers. After the hands were injected roentgenograms were made and the hands were then frozen and sectioned transversely or longitudinally. These sections were carefully studied to determine the exact location of the barium mixture.

#### INJECTION EXPERIMENTS

*Hand 1 Left hand* The needle was pushed through the skin and under the extensor tendon over the region of the third metacarpophalangeal joint. The fluid was injected under considerable pressure. The injection mass could be seen to distend the tissues of the dorsum over the joint and proximal ward for some distance over the hand.

Anteroposterior and lateral roentgenograms (Fig. 1) show the joint space obscured by the shadow of the gelatin barium mixture which has spread proximally over the metacarpal head and shaft and diffused somewhat in the contiguous interosseous spaces. The mass appears to be most dense over the head of the metacarpal bone, in the position occupied by the subtendinous bursa. The lateral roentgenogram shows the curved tract left by the solution along the course taken by the injecting needle. Details of the injection in the lateral picture are obscured by the overlying bone shadows, but it appears that the mass is densest just proximal to the joint space, i. e., in the region of the subtendinous bursa.

Cross sections (Fig. 3) show that the injection material has not extended distally beyond the joint capsule. It has, however, ruptured proximally so that it lies over the dorsum of the third metacarpal bone and the interosseous spaces between the second and third, and third and fourth metacarpals. In a section made through the hand about midway between the heads and bases of the metacarpals (Fig. 3A) the mass lies under the dorsal tendons and aponeurosis. It has infiltrated the dorsal interosseous fascia to some extent and at one point between the third and fourth metacarpals it has entered the substance of the dorsal interosseous muscle.

A section through the metacarpophalangeal articulations (Fig. 3B) shows the gelatin mixture in the

joint space and under the extensor tendon. It has been directed by the lateral attachments of the tendon around the lateral surface of the joint capsule. It has pushed volarward for some distance, more on the radial than on the ulnar side and lies in very close apposition to the thin fascia covering the interosseous muscles.

*Hand 2 Left hand* The needle was pushed into the tissues over the dorsum of the third or middle metacarpophalangeal joint into the joint cavity and pulled back slightly so as to lie in the cavity but not between the bones.

The anteroposterior roentgenogram (Fig. 2) reveals a tremendous spread of the injection mass. The spaces of the third and fourth metacarpophalangeal joints are obscured over their entire extent, while that of the index finger is obscured over its ulnar half. The mass has extended distally along both sides of the middle and ring fingers and on the ulnar side of the index finger half or more the length of the proximal phalanx. The spaces between the heads of the four medial metacarpals are blurred by the barium which has extended proximally over the dorsum to about the middle of the metacarpus, where it is especially marked over the second and third interosseous spaces.

Cross sections made of the hand show a rather curious distribution of the barium gelatin mixture. In Figure 4 the sections are arranged in order, the most proximal above. In the section (Fig. 4A) taken just distal to the base of the metacarpus the mass lies beneath the extensor aponeurosis, between it and the metacarpal bones and dorsal interosseous fascia. A section (Fig. 4B) taken slightly farther distalward shows the mass still underneath the tendons and spread out over very nearly the entire dorsum of the metacarpus. It is held on the ulnar side by the attachment of the dorsal aponeurosis to the side of the fifth metacarpal. On the radial side it is held by a loose fascial attachment of the aponeurosis to the second metacarpal. In a section passing close to the heads of the metacarpals (Fig. 4C) the injection mass is seen to be not only dorsal to the extensor aponeurosis but volar to it as well. It lies volar to it, however, only over the third metacarpal where it has filled the joint capsule and the subtendinous bursa. To reach the dorsal surface of the aponeurosis from its point of injection into the joint cavity, the material apparently has passed through the attachments of the capsule to the under surface of the extensor tendon. It is possible to trace direct continuity of the barium gelatin mixture from its position under the tendon to the web of the fingers where it lies superficial to the aponeurosis.

From the point of its rupture through the joint capsule it has passed distalward as well as proximalward. Distally it can be traced over the index, middle, and ring fingers (Fig. 4E) where it lies between the dorsal tendons and a thin fascial sheet which represents the dorsal portion of the deep digital fascia. Here it lies in a crescentic space, the apices of which pass to either side of the phalanx and



he in close juxtaposition to the nerve and vascular tunnels of the volar surface. They are separated from these tunnels by a very thin fascial sheet. It is to be noted, however, that they are separated from the flexor tendons by the double layer of fascia enclosing the nerves and vessels and by the dense fibrous sheath of the flexor tendons.

**Hand 3 Right hand.** The needle was pushed into the third metacarpophalangeal joint space and the injection made. The needle was then pulled out slightly so that although it lay in the joint cavity it was not between the bones. The roentgenogram (Fig 5) of this hand shows that the material is massed about the point of injection filling the joint space and the subtendinous bursa and present in small amount in the second and third interosseous spaces.

In a longitudinal section of the hand through the midline of the middle finger and third metacarpal bone (Fig 6), the injection mass within the metacarpophalangeal joint is seen to have gained the volar space of the joint cavity where it lies against the tough volar plate which completes the joint capsule here. Dorsally the injection mass has ruptured through the joint and has spread through the subtendinous bursa and proximalward for a slight distance under the tendon.

**Hand 4 Right hand.** The needle was thrust into the second metacarpophalangeal joint and the injection was made with considerable force. The needle was then pushed slightly radialward and volarward and further injection was made. The mass ballooned out the thenar space and dorsum of the hand.

The roentgenogram (Fig 7) shows a haziness over the whole radial one half of the metacarpus. Over the middle of the metacarpus some of the material has reached the fourth metacarpal bone and is seen to extend proximally over the wrist. The first interosseous space is obscured, but it is not possible to say from the roentgenogram alone whether the thenar space is involved.

Cross sections of the hand reveal a remarkable infiltration of the tissues. On transverse section through the metacarpophalangeal joints (Fig 8A, frontopiece) the second joint is filled with the barium mixture but the capsule has not ruptured. The material which lies outside the joint cavity presumably reached that position when the needle was pushed through the capsule though it is not improbable that some may have been forced from the joint cavity and into the subtendinous bursa. The mass external to the joint cavity lies underneath and above the extensor tendon of the index finger and about and in the fibers of the first dorsal interosseus and first lumbrical muscles.

A section taken somewhat proximal to the preceding one (Fig 8B), so that it passes through the thenar space, shows the mass to be widely distributed on both the volar and dorsal surfaces of the hand. On the dorsum the gelatin has spread ulnarward under the tendons to the middle of the space between the fourth and fifth metacarpals and has

infiltrated slightly the second dorsal interosseous muscle. Dorsal to the extensor expansion it has spread as far as the fourth metacarpal. The subtendinous mass is not so thick as the subtendinous mass. Along the radial border of the hand the material appears to have been guided by the fascia covering the first dorsal interosseous muscle. It has passed between the fascia and the muscle and spread into the space between the latter muscle and the adductor pollicis as far as the first volar interosseous muscle. It has also followed the radial border of the adductor pollicis and lies between this muscle and its fascia. It has reached the volar surface of the adductor pollicis and passed ulnarward over the volar surface of this muscle in the floor of the thenar space.

Farther proximalward less and less of the mass lies on the volar surface. The first dorsal interosseous muscle is permeated with the mixture and there is gelatin between it and the adductor pollicis, and still some in the floor of the thenar space. On the dorsum, however, the infiltration becomes more marked as the bases of the metacarpals are approached. The greater part of the injection material lies deep to the dorsal aponeurosis and has spread to the ulnar side of the hand. It has spread just as widely, but not in such great amount, on the dorsal surface of the tendons.

A section (Fig 8C) taken through the bases of the metacarpals shows the extent of the material superficial and deep to the dorsal aponeurosis. It also shows the infiltration of the first dorsal interosseous muscle.

More proximally (not illustrated) the mass is seen to be confined more and more to the radial side of the wrist. Very little of it lies superficial to the tendons. As the region of insertion of the extensors carpi radialis appears in the sections the tendons lie deep to the injection mass which now entirely embeds the tendon of the extensor pollicis longus. A section taken still farther proximalward over the region of the dorsal tunnels shows the injection material lying just under the deep fascia along the radial side of the wrist between the extensor carpi radialis longus and brevis and the extensor communis tendons. Because of the attachments of the deep fascia at the wrist none of the mass has gone farther proximalward than the radial styloid.

**Hand 5 Left hand.** The injection was made under the tendon on the dorsum of the proximal phalanx of the ring finger about 1.5 centimeters distal to the metacarpophalangeal joint. The needle was pointed proximalward and the solution was seen first to fill up the tissues over the proximal phalanx and then to pass proximalward over the metacarpophalangeal joint.

The roentgenogram (Fig 9) shows that the routine arterial injection made in preparing the cadaver for dissection overshadows somewhat the results of the barium gelatin mass injection. The mass is seen to cover the proximal five sixths of the proximal phalanx, the metacarpophalangeal joint, and the head

of the fourth metacarpal bone. Between the ring and little fingers the mass is seen to extend almost to the proximal phalanx of the fifth finger, it does not reach the fifth metacarpal. On the radial side of the fourth metacarpophalangeal joint the mass does not extend quite to the borders of the joint.

The specimen was divided into two parts by a longitudinal section through the midline of the ring finger and its metacarpal. The ulnar half was further divided into cross sections.

The radial half. The injection mass is seen to diffuse very slightly just under the skin at the point of injection. The main body of the material lies under the extensor tendon of the finger. Distally it extends almost to the head of the first phalanx, proximally it extends to the attachment of the extensor tendon to the joint capsule, which it has infiltrated, and lies within the loose tissues between the head of the metacarpal and the tendon.

The cross sections of the ulnar half (Fig. 10) show a much more extensive distribution of the injection mass. In the fingers (Fig. 10A) the mass extends under the extensor tendon from side to side to the points at which the tendon is loosely attached by fascia to the sides of the phalanx. It is interesting to note how well the flexor tendons in their synovial sheath are protected from the injection material. At the base of the finger (Fig. 10B) the same distribution is noted. At this point the extensor expansion is made up of the central slip which comes from the extensor communis and the lateral slips which come from the lumbricals and interossei.

A section taken through the metacarpophalangeal joints (Fig. 10C) shows that a small part of the mass has passed from the dorsum and now lies on the volar surface in the fascial coverings of the fourth lumbrical muscle volar to the transverse metacarpal ligament. On the dorsum the barium gelatin mixture lies under the extensor tendon and interosseus muscle. The volar mass is still prevented from getting into the flexor tendon sheath by the digital fascia and the fibrous tendon sheath. It would extend more easily into the palm than into the tendon sheath. Still farther proximalward (Fig. 10D) a very small mass of barium lies under the fascia covering the fourth lumbrical muscle while on the dorsum the mass lies under the extensor tendon confined by loose fascial attachments directly over the fourth metacarpal bone.

**Hand 6. Right hand.** The injection was made into the "knuckle" of the flexed ring finger, the needle was pushed proximally into the joint cavity through the tendon and then pulled back about 1 millimeter.

On roentgenologic examination of the hand (Fig. 12) the mass is seen to be confined to the region of the metacarpophalangeal joint where it overshadows the joint space. In the lateral exposure it is seen to have filled the tissue under the tendon and the subcutaneous bursa.

On cross section (Fig. 11) the mass is seen to be confined to the region of the metacarpophalangeal

joint. A section through the joint shows the cavity filled with barium gelatin mixture and the loose tissues under the tendon also permeated by the mass. There has been no lateral spread. Some of the mass, as shown in the roentgenogram, also lies above the tendon, evidently the result of leakage from about the needle tract.

**Hand 7. Right hand.** In this hand the needle was pushed through the tendon on the dorsum of the proximal phalanx of the middle finger about 1.5 centimeters distal to the metacarpophalangeal joint and slightly to the radial side of the phalanx.

In the roentgenogram (Fig. 13) the mass appears partially to encircle the ulnar half of the phalanx. There seem to be two separate spaces in which the mass lies, one close to the bone, the other overlying the deeper compartment. It appears to be separated from the latter by soft tissues, which in the sections proved to be the extensor tendon. Although some of the injected material overlies the joint space none actually enters it.

On cross section examination these facts are confirmed (Fig. 14). In the region of the joint (Fig. 14A) some of the mass lies between the tendon and the base of the proximal phalanx on the ulnar side, but none is in the joint. Presumably the attachment of the tendon to the capsule prevents further spread proximalward. In a more distal section, through the base of the proximal phalanx (Fig. 14B), the mass lies entirely under the extensor tendon. More distally, however, over the middle of the phalanx (Fig. 14C) some of the injection material has spread about the ulnar side of the tendon and dorsally for a short distance superficial to the extensor tendon, where it lies between the tendon and the deep digital fascia.

**Hand 8. Left hand.** The injection in this hand was made into the cleft between the middle and ring fingers on the dorsum, on a level with the heads of the metacarpal bones.

When viewed in the roentgenogram (Fig. 16) it is evident that the greater part of the injected material lies to the ulnar side of the midline between the ring and middle fingers and their metacarpals. Some of it, however, has spread beyond this line radialward and lies over the third metacarpal. Although the joint space cannot be easily visualized, stereoscopic plates show that the cavity is not filled with the barium mixture. Along the base of the ring finger the mass extends distally about one-fourth the length of the phalanx from which it is separated by soft tissues.

Sections made of this hand close to the bases of the metacarpals (Fig. 15A) show that the mass has spread widely both deep and superficial to the extensor tendons, somewhat more widely under than above them. Nearer the heads of the bones (Fig. 15B) the spread has been less extensive. Most of the material lies between the aponeurosis and the

<sup>1</sup> The sites of injection in hands 8 and 9 and the results obtained are very similar to those described by Kanavel in *Infections of the Hand*, pp. 138-140.

fascia where it covers the space between the third and fourth metacarpals and overlies the fourth metacarpal as well. A smaller amount of the mass lies under the aponeurosis directly on the dorsal interosseous fascia between the third and fourth metacarpals, it has penetrated this fascia to some extent.

In the region of the metacarpophalangeal joints (Fig 15C) the material has spread volarward pushing aside and infiltrating the interosseous muscles and reaching the transverse metacarpal ligament. A section through the bases of the proximal phalanges (Fig 15D) shows that the barium has spread distally under the deep layer of digital fascia. It has not penetrated to the volar surface of the finger. A section taken more distally on the ring finger (Fig 15I) shows the material between the extensor tendon and the deep digital fascia but none on the volar surface.

**Hand 9.** Left hand.<sup>1</sup> In this hand the needle was pushed through the tendon on the dorsum just over the head of the fifth metacarpal. Apparently the joint space was not entered.

The roentgenogram of the injected hand (Fig 17) shows a very definite localization of the mass to the ulnar side of the midline of the fourth metacarpal bone. Although the ulnar half of the fifth metacarpophalangeal joint is obscured by the barium the cavity does not appear to be filled with the material. The lateral view of this hand shows the great amount of material injected and speaks for the definiteness of the fascial attachments of the tendons which prevent further radial spread.

Sections made of this hand show that the barium gelatin mixture has spread proximally almost to the carpometacarpal joints. In the most proximal section (Fig 18A) the mass overlies and to some extent underlies the extensor tendons over the third and fourth metacarpals. Curiously it appears to be limited by the delicate attachments of the dorsal aponeurosis to the subcutaneous fascia. There is seen in this section a ring like infiltration about the tendon of the extensor digiti quinti proprius.

A section taken about 1 1/2 centimeters distal to the base of the metacarpals (Fig 18B) shows a very large amount of the mass lying dorsal to the tendons and under the dorsal fascia. Some of the mass lies under the aponeurosis over the space between the fourth and fifth metacarpals. The slight attachments of the tendons to the deep fascia here are evidently confining the mass to this location.

Still farther distalward (Fig 18C) the distribution appears to be about as in the previous section. The mass extends ulnarward as far as the fascial attachments of the dorsal fascia to the fascia over the hypothenar muscles while on the radial side it stops opposite the fourth metacarpal. There is a very slight amount of the mass under the aponeurosis over the fifth metacarpal.

Over the metacarpophalangeal joint of the fifth finger (Fig 18D) one sees injected material in the compartment formed by the attachments of the dorsal fascia to the dorsal aponeurosis.

(It must be assumed that in this experiment the needle was pulled out of its position under the tendon and came to lie over the tendon.)

From these injection experiments we believe that the course of spread of the process from tooth injuries in the region of the metacarpophalangeal joints, the proximal phalanges of the fingers, and the loose tissues in the web is by the following routes:

From the joint space it probably ruptures first proximally into the thin walled bursa overlying the head of the metacarpal and underlying the extensor tendon (Hand 3, Figs 5, 6). It is not confined here by the thin walls of this sac, but breaks through and gains the subaponeurotic space, through which it spreads proximally under the tendon (Hand 1, Figs 1, 3). Its lateral extension under the tendon is hampered to some extent by the loose areolar tissues running from the under surface of the tendons to the dorsal interosseous fascia and metacarpal bones (Hand 9, Figs 17, 18). Following this subtendinous pathway it may extend proximally as far as the wrist joint and laterally over a considerable extent of the dorsum. As the pus ruptures from the subtendinous bursa it comes to lie in the loose areolar tissues in the proximal part of the web of the fingers and thence may spread laterally and distally (Hand 2, Figs 2, 4). In this position it lies dorsal or external to the extensor tendons and as it spreads distally over the fingers it lies between the deep digital fascia and the aponeurosis. It may also spread proximalward from this position and therefore for a certain distance lie dorsal to the extensor aponeurosis over the dorsum of the hand.

As it lies in the web, it comes into close relationship with the tendons of the volar and dorsal interosseous muscles (Fig 3), which are covered by a thin sheet of fascia, and it is reasonable to assume that extension into the interosseous spaces of the hand could take place along the tendons after invasion of the fascia.

As was emphasized above the volar attachment of the joint capsule to the proximal

<sup>1</sup>The sites of injection in hands 8 and 9 and the results obtained are very similar to those described by Kanavel in *Infe. tows of the Hand*, pp 138-140.

phalanx is very secure and immobile, while its attachment to the head of the metacarpal bone is loose, so as to allow free movements. This thin sheet of synovial membrane and fascia would offer very little barrier to extension of purulent material from the joint into the tissue lying between the metacarpal bone and the volar interosseous fascia (Fig 6)

When the infection lies in the finger between the extensor aponeurosis and the deep digital fascia it is in close proximity to the vessels and nerves in their fascial tunnel (Figs 4B, E, 10A, B, 14B, C, 15D, E) Although none of the material has been forced into the fascial tunnel, its walls are so thin that it would be quickly invaded by infection. It is to be noted that the flexor tendons and their synovial sheaths are well protected by the dense fibrous tendon sheath, and one would not expect a tenosynovitis to occur except late in the course of the infection. The lumbrical tendons which extend along the side of the finger to insert into the extensor tendon also lie in close relation to any infectious material which lies under the deep digital fascia. They are covered by thin fascia which is not a very secure barrier to extension proximward. Should the process follow along one of the lumbrical tendons it would soon reach the lumbrical canal and one of the large fascial spaces of the palm (Hand 5, Figs 9, 10)

Injection of the gelatin barium mixture beneath the extensor tendons resulted in one case in actual injection of a lumbrical muscle and extension within the substance of the muscle into the palm. Clinically this is a common method of extension.

In one experiment in which the needle was forced through the lateral surface of the second metacarpophalangeal joint into the substance of the first interosseus muscle, the gelatin mass besides involving an extensive area over the dorsum, found its way palmarward and into the thenar space (Hand 4, Figs 7, 8). This extension has been observed clinically.

#### CLINICAL STUDY

While it is true that no two cases are ever exactly similar in any disease, there are so many things in common in mouth bite in-

fections that a fairly typical clinical picture can be drawn. For sake of clarity we wish to present such a picture before making a more detailed study of the variations.

The patient, a young man, presents himself to a physician with a lacerated wound on the dorsum of the hand over one of the metacarpophalangeal joints. The manner in which the wound has been received is frequently not disclosed and the possibility that the wound is due to a tooth injury therefore may not occur to the physician. After the wound is cleansed and the edges of the skin trimmed away, surgical closure is often made, and it may be thought wise to suture a divided tendon and close the joint cavity.

Twenty-four or 48 hours later the patient again presents himself complaining of severe pain in the hand. The hand is then found to be considerably swollen. A lymphangitis may be present at this time, though it is by no means constant. The constitutional symptoms are not especially marked, but there is a moderate fever and a mild leucocytosis. The sutures, if any, are removed and hot wet packs applied to the hand, forearm and arm.

The pain subsides, but the swelling and fever persist and after several days it becomes apparent that drainage is inadequate and that lateral and proximal extension has taken place. By this time the secretion from the wound is moderately profuse and usually of a very disagreeable odor, if the true nature of the infection has not been disclosed it is now suspected. The original wound is opened more widely and found to communicate with the joint cavity. A considerable amount of grayish-brown fluid pus, exceedingly malodorous, is released. Similar pus is found in the soft tissues at either side of the affected joint and beneath the extensor tendon. Smears and cultures made from the pus show many organisms, among which may be the fusiform-spirillum combination of Vincent. Drainage of the wound leads to a fall in temperature and an immediate though temporary improvement.

Soon, however, there appears an induration in the palm, either over a lumbrical canal or over one of the larger fascial spaces, i.e., the middle palmar, or, very rarely, the thenar

space. These extensions require drainage, and at operation it is noted that with pressure on the dorsal and volar surfaces of the metacarpophalangeal joint purulent material can be expressed from the palmar incisions. At the same time or later the proximal phalanx of the affected finger also shows swelling and signs of exudate. The finger becomes swollen and indurated, painful on extension, and moderately tender. The tenderness is most marked over the sides of the finger and over the metacarpophalangeal joint. There is slight or no pain over the two distal phalanges and no local pain over the course of the tendon sheath. The sides of the finger are incised, and more of the purulent exudate is released. The fibrous tendon sheath is seen to be intact though evidently inflamed but the impression gained is that there is no pus within the sheath and it is not opened. From now on improvement takes place. The exuberant, oedematous, weak looking granulations become more red and solid. The discharge becomes progressively less, the odor disappears and after several weeks or a month or more the wounds finally heal, leaving a stiffened finger.

At irregular intervals following closure of the wound "flare ups" occur. These consist of acute inflammatory reactions either on the dorsum of the hand under the original site of injury or in the palm. These areas are incised and the inflammation subsides promptly under hot moist packs. Cultures from these foci may show fusiform bacilli, staphylococci and other organisms are usually present. This "lighting up" may be repeated several times before final cessation, and may occur as late as 18 months after the original injury. (Case 2). In some instances bone and joint involvement may have led to amputation early in the process.

#### DISCUSSION OF CLINICAL COURSE

In our series of 13 cases there were 12 males and 1 female, a ratio such as we should expect from the nature of the injury. All but 2 patients were young adults, from 18 to 38 years of age, patients 9 and 10 were 51 and 54 years of age respectively. In 10 instances the right hand was affected, in 3 the left hand. In all but 3 instances the injury was due to the

patient striking another individual on the mouth and traumatizing the hand against a tooth. In 2 cases the patient was actually bitten, in 1 case on the right index finger, in the other on the left thumb, in each instance by a woman. In 1 instance the patient claimed to have injured himself with a tooth brush, a story which he maintained up to 18 months after the original infection. Either the story was true or the patient realized the importance of disclosing at least the nature of the source of the infection in a non committal manner.

Two patients directly falsified at the time first aid was rendered. In 3 cases (3, 6, and 13) the patients were cared for in a hospital and fairly large lacerated wounds were sutured. Had the patients told the truth wound suture would certainly not have been performed and a more extensive disinfection of the wound would surely have been carried out.

With such a small series of cases it is difficult to evaluate the effect of the primary treatment. In 7 instances the wound was taken care of immediately by a physician. In 3 cases the usual antiseptic treatment was applied, in 3 primary suture was performed in the belief that the wound had been received under fairly clean circumstances. In 4 instances the patients applied different antiseptics themselves and consulted physicians only after swelling and pain developed. In one case nothing was done to the wound until infection developed and a physician was at once consulted. In one case no record was made as to the first aid treatment. The case in which the infection was the mildest and the one in which amputation of the arm was finally necessary were both self treated at first.

The interval of time elapsing between the reception of the injury and the onset of symptoms due to the infection was usually short. In most cases there were pain and swelling on the day following the blow. In Case 12 considerable swelling and pain were present 3 hours following the injury. In Cases 5, 6, and 13 there was considerable pain 12 hours after injury, while in the other cases, except Case 4, the interval given is 2 or 3 days. The fourth patient treated the wound himself and worked

for 10 days with no symptoms, then, following a slight trauma, a lymphangitis developed.

*Extension of infection from the primary wound.* The extent and manner of spread of the infection throughout the tissues indicate an extension along the fascial planes as described above, and direct involvement of the joint. In all instances, except in Case 4, in which it seems probable that the infection did not get below the digital fascia, and in Cases 9 and 11 in which a digit was actually bitten, there was first a local though diffuse extension underneath the dorsal fascia or aponeurosis in the region involved. This extension was concentric and resulted in accumulation of purulent exudate under the tendon and in the lax tissues on one or both sides of the tendons in the space between the heads of the metacarpals. In 7 instances the infection followed through the joint into one of the fascial spaces in the palm (Cases 1, 2, 3, 5, 7, 8, and 12). In 3 instances the middle palmar space was involved (Cases 5, 7, and 12) and in 2 others (Cases 3 and 8) the thenar space.

The determination of extension by fascial planes is excellently illustrated by Case 9, in which amputation became necessary. Examination of the arm at the time of amputation showed that the exudate and gangrenous process lay between the skin and the deep fascia covering the muscles, while the muscles themselves presented a normal appearance.

When the lumbrical canal is involved the infection as a rule gains entrance either by involvement of the tissues in the web or by extending proximally along the fascia of the lumbrical muscle, and the infection may remain confined to the lumbrical canal without further volar extension.

The local spread under the extensor aponeurosis becomes manifest almost at once, and it is frequently found necessary to provide for drainage in the spaces between the heads of the metacarpals at the same time the original wound is opened for better drainage. Further spread into the palm via the lumbrical canals or about the digital vessels and nerves takes place later. In general the palmar extension is evident in from 10 to 14 days following the injury, though there is apparently no definite

time limit. In Case 3 the thenar space was invaded 4 or 5 days after the original injury, while in Case 2 the palmar extension was first noted one year after the original injury. In the latter case it is to be emphasized that the recurrence of trouble was due to a slight trauma. Such a train of events would indicate that the organisms reached the palm, but remained quiescent until the slight injury to the tissues caused a lighting up of the infection.

Another method of extension, illustrated in Cases 5 and 7, is about the proximal phalanx of the involved finger. In each instance this extension was noted during the third week, i. e., after the extension into the palm. Pus in these cases was located laterally on the fingers, presumably under the deep digital fascia, and did not extend across the volar surface of the phalanx until later. Such swelling, associated with the considerable pain on motion of the finger due to joint involvement, and volar tenderness, due also to infection in the metacarpophalangeal joint may lead one to suspect invasion of the flexor tendon sheath. There is not, however, rigidity of the whole finger as in tenosynovitis, only the metacarpophalangeal joint is held flexed while the interphalangeal joints can be moved with slight pain. The tenderness is also usually confined to the sides of the proximal phalanx and the volar and dorsal surfaces of the metacarpophalangeal joint. In Case 7 the possibility of an infection of the flexor tendon sheath was considered before incision of the lateral digital extension. It was decided not to open the sheath both because of the absence of unequivocal physical findings, and because it was believed that if the sheath were already involved, the tendons could not be saved, and that if it were not involved, opening of the sheath would surely lead to infection and necrosis of the tendons. The subsequent course of events proved the wisdom of this decision, and the experimental observations described above show why the flexor tendon sheath is not commonly involved.

*Bone and joint involvement.* Some involvement of the bones and joints was shown to be present in 10 of the 13 cases (Figs 19, 20, 21, 22, 23, 24, 27, 28, 29, and 34). In eight of these the metacarpophalangeal joint was involved

and roentgenologic examination showed rarefaction and some destruction of bone. The arthritis quite evident clinically in the early stages of the infection can be roentgenologically proved during the second or third week. In two instances (Cases 6 and 7), in which we had opportunity of securing several roentgenograms, the bone involvement was seen to improve with conservative treatment. The destructive process in the joint and in Case 7 the periosteal proliferation showed evidences of healing and clinically a return of motion. In only 3 instances was bone involvement sufficient to lead to operative attack on the bone. In Case 3 a very persistent discharge with a continuous moderate rise in temperature lead us to curette the joint space. This we know now was a mistake since it lead at once to a severe osteomyelitis of the proximal phalanx and metacarpal bone and healing took place only after removal of the involved parts of these bones. In another instance a bite had lead to considerable osseous destruction about the distal interphalangeal joint (Case 11, Fig. 34) and a few bits of necrotic bone were removed at the time of incision. No further operative treatment was required. In the third instance (Case 12) the head of the fourth metacarpal was found to be necrotic at the time of operation and had to be removed. Apparently the bone infection is chiefly a periostitis and unless sequestrum formation develops it is better treated conservatively. If adequately drained, the infection of the joint cavity gradually clears up and does not necessarily lead to a bony ankylosis (See especially Cases 6 and 7, and Figs. 23, 24, 27, 28, and 29.)

*Recurrences of infection.* A word should be added about late manifestations of infection. These may occur during the first 2 or 3 months after injury, or as in Case 2, may not appear for a year after the original injury. In this connection Case 4 presents particular interest. Here the wound had healed within 10 days after its reception. A slight trauma, however, was sufficient to cause the infection to flare up again. In Case 6 there were four recrudescences of the infection—3 months,  $4\frac{1}{2}$  months,  $5\frac{1}{2}$  months, and 11 months after the original injury. One of these can be definitely ascribed

to the application of a splint which fit tightly over the involved joint. In Case 2 the palmar extension did not become manifest until a year after the initial infection and followed slight trauma to the palm from the handle of a barber's chair.

#### BACTERIOLOGICAL FINDINGS

Records of cultures or smears are found in 7 of our 13 cases. In one instance (Case 3) a pure culture of bacillus proteus vulgaris was obtained. This infection was especially destructive, lead to extensive osteomyelitis of the bones entering into the formation of the joint, and subsided only after resection of considerable portions of the bones. In Case 5 smears and a single culture showed a mixed infection with no apparent predominant type. No fusiform bacilli or spirilla were seen. Anaerobic cultures were not made and it is therefore not possible to say if bacillus fusiformis was present or not. In Case 6 three cultures were made. At first a single aerobic culture gave a pure growth of staphylococcus albus. A month later careful anaerobic cultures made by Dr. W. J. Nungester of the Department of Bacteriology, Northwestern University Medical School, failed to yield any growth. Another month later smears and anaerobic culture showed a pure growth of bacillus fusiformis (Fig. 25). In this case the infection persisted for 7 months. During the latter part of this time, at intervals of almost exactly 1 month, acute exacerbations occurred. The area of the original injury became red, swollen, and painful. On each occasion a simple stab incision released 1 or 2 cubic centimeters of pus, and hot, wet dressings for a few days resulted in complete cessation of both pain and discharge. At the last recrudescence of the process about 3 cubic centimeters of pus was released. Numerous smears made of this pus revealed no organisms.

It is interesting to speculate as to the reason for the almost clock like regularity of the "flare ups." The causative organism grew only under strict anaerobic conditions and began to appear in the cultures only after some 6 days. It may be that the incisions changed their oxygen relations, that after closure of the wounds they began to multiply



Fig. 19

Fig. 20

Fig. 21

Fig. 22

Fig. 23

Fig. 24

Fig. 19 Roentgenogram of hand, Case 1, showing periostitis of the proximal phalanx of the middle finger and decrease of joint space

Figs. 20 and 21 Roentgenograms of hand, Case 3 showing the progressive destruction of the metacarpophalangeal joint of the index finger

Fig. 22 Roentgenogram of the hand, Case 5 showing the

obliteration of the joint space of the metacarpophalangeal joint of the middle finger

Figs. 23 and 24 Roentgenograms of hand, Case 6 showing obliteration of the joint space of the metacarpophalangeal joint of the middle finger and atrophy of the bone. This is more marked in Figure 23. Figure 24, taken 4 months later, shows definite improvement in the process.

again and reached a sufficient growth to lead to symptoms only after 4 to 5 weeks. Possibly trauma lead to the exacerbations.

In Case 7 several smears and cultures were made. At first staphylococcus aureus and albus only were recovered. Later a mixture of staphylococcus aureus, bacillus mucosus capsulatus, and streptococcus salivarius was obtained. At another time a smear yielded various coccal forms and a culture made at the same time by Dr. A. A. Day of the Department of Bacteriology, Northwestern University Medical School, yielded a pure culture of streptococcus salivarius.

In Case 8 streptococci, staphylococci, and bacillus coli were found. This might well be expected though we have not found bacillus coli mentioned previously as a contaminant in mouth bite injuries.

Smears made from Case 11 (Fig. 33) showed the typical bacillus fusiformis-spirillum combination which is so frequently reported as having been found.

In Case 13 one set of cultures prepared anaerobically revealed no growth. A second set of cultures prepared at the time Dr. Shearon incised the finger yielded a hemolytic streptococcus and an anaerobic gram negative bacillus, not bacillus fusiformis.

While the bacteriological study of our cases is by no means complete it represents fairly well the conditions present. The infection is not due to any one type of organism, but in every instance is a mixed infection, certainly at the onset. The fusiform spirillum combination is frequently found, and is accountable in part for the foul smelling, gangrenous lesions so often present. These organisms are associated, however, with others found in the mouth, especially staphylococci and streptococci. In none of our cases was the spirochaeta pallida implanted.

#### PROGNOSIS

The patients are incapacitated for a considerable period of time following the injury.



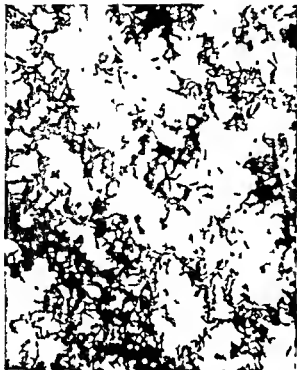


Fig. 23. Pure culture of fusiform bacillus taken from Case 6 6 months after the initial infection

Except in very mild infections in which the organism has not been introduced below the various fascial sheets of the hand the period of disability is reckoned in months and weeks instead of days. Patients 3, 6, and 7 were incapacitated for 3, 7, and 5 months, respectively, following the onset of the infection and even then had residual disability.

None of the patients have succumbed to the infection, though in one instance (Case 9) it was necessary to amputate the arm because of an ascending gangrenous infection which followed the fascial planes up the forearm and threatened the patient's life. In no other instance did the infection appear to be dangerous to life and in no other case was amputation of even a finger necessary to cure the infection. In Case 3 a flail finger resulted from removal of the joint, a procedure which resulted in controlling the infection, but led to a useless digit which might have been better amputated in the first place. In the cases treated conservatively, notably Cases 6 and 7 in which the bone was not "scraped," the arthritis and periostitis gradually improved

and both patients are beginning to show movement in the involved joint. While it is doubtful if complete restoration will take place still there is a fair degree of movement of the affected fingers and such a termination is preferable to amputation.

#### TREATMENT

The principles of treatment of bite infections are not different from those of other infected wounds, but the factors emphasized above—the complicated anatomical arrangement of the tissues of the dorsum of the hand and fingers, which predispose to the extension of infection rather than to limitation of it, the presence of a mixed infection with organisms of relatively high virulence, and the relatively low resistance of fibrous connective tissue to infectious processes in general—tend to prolong unduly the course of such infections, to predispose to the destruction of fascia and tendons and to the involvement of bones and joints, and, as a result, to produce eventually a more or less extensive impairment of function.

Although we have not had the opportunity of treating a single case primarily, or immediately after the injury, we believe, as a result of our observations, that the most important factors in the primary treatment are careful cleansing of the wound without any attempt at wound closure, hospitalization, and either the immediate application of warm, wet, sterile dressings, or institution of Carrel-Dakin treatment, with the utmost care to prevent the addition of further infection.

Cleansing of the wound, we believe should be done gently, and with soap and water rather than with powerful chemical solutions which are quite as likely to kill living cells as to kill bacteria which have been introduced into the tissues. Obviously damaged tissue should be cut away, and the wound left widely open without any packing or gauze which might interfere with drainage. In Case 7 which was first seen by us days after the injury, the wound had been tightly packed with a gauze "drain," which acted instead as a barrier to the escape of infectious material. Its removal was followed by the discharge of a considerable amount of foul pus, which in this



Fig. 26 Photographs of the right hand Case 6, 8 months after the infection. The scar at the site of the injury is seen on the dorsum over the third metacarpophalangeal joint. Function of the finger has returned practically to normal.

case had acted just as the barmum gelatin when injected subcutaneously under pressure.

The continuous application of warm, wet, sterile dressings produces an active hyperæmia and mobilizes the forces that overcome infection. It should not be continued, however, long enough to produce oedema of the part and maceration of the superficial tissues. Intermittent soaking in warm, sterile solution, or the use of Dakin's solution should be substituted for the continuous warm, wet dressing before the hand becomes congested—usually at the end of 3 or 4 days.

Extension of infection should be carefully watched for. The surgeon should remember that extension of infection is likely to take place (1) lateralward in the soft, superficial subcutaneous tissue of the dorsum of the hand, (2) under the digital fascia of the proximal phalanx, and so around the finger, (3) more deeply, distalward along the proximal phalanx under the extensor tendon, with subsequent periostitis and osteomyelitis, (4) on the dorsum of the hand, as distinguished from the finger, under the extensor tendons and the fibrous tissue which unites them to form the dorsal aponeurotic layer, (5) along the lumbrical canal into the palm and thence into the middle palmar or thenar space, (6) less commonly, and usually at the end of 10 or 12 days, through the joint into the palm, under the volar interosseous fascia and thence into the middle palmar or thenar space, and (7) by erosion of the fibrous flexor tendon sheath into the sheath, with involvement of the synovial sheath and flexor tendons.

Successful treatment requires the recognition of extension of infection to these different sites, and incision before the accumulation of pus under pressure causes extensive necrosis of tissue. Incisions for drainage, needless to say, must be made with due regard for important anatomical structures. If infection extends through the joint into the palm, the affected space in the palm should be drained, but through-and-through drainage of the hand, we believe, is never indicated.

"Scraping of the bone" and curettage of the joint cavity, as has been emphasized above, is likely to do more harm than good. If the infection of the soft tissues, fascial spaces, and the affected joint is adequately drained, bone involvement tends to clear up spontaneously. We have seen sequestrum formation in only one case, even though roentgenograms have shown evidence of extensive periostitis and grating sounds on movement have given definite evidence of destruction of joint cartilage. Even though joint cartilage is destroyed, bony ankylosis does not necessarily take place, and mobility may still be preserved if efforts are made to prevent fibrous ankylosis by the institution of early movement.

A word of warning may be in place with regard to the interpretation of roentgenograms in these cases. Not infrequently the surgeon or radiologist forgets how quickly atrophy of tissue makes itself apparent by the absorption of lime salts from the bones of the hand. A diagnosis of osteomyelitis and bone destruction has been made on several occasions when



Fig 27

Fig 28

Fig 29

Fig 27 Roentgenogram of the right hand Case 7 taken February 4 1930. The destructive process is distinctly visible in the fourth metacarpophalangeal joint. Its further progress is seen in Figure 28 and its diminution in Figure 29.

Fig 28 Roentgenogram of Case 7 taken February 25 1930. Compare with Figures 27 and 29. There is considerable destruction of bone and periostitis of both the proximal phalanx and metacarpal bone of the ring finger.

Fig 29 Roentgenogram of right hand of Case 7 taken April 12 1930. Compare with Figures 27 and 28. Definite evidence of healing is present.

slight infection was present and the process of rarefaction was mistaken for infection.

Involvement of the flexor tendon sheath, as has been pointed out above, is unusual. It occurs as a late result of extension of the infectious process through the metacarpophalangeal joint into the palm. In one case (Case 10) this palmar extension was not recognized until erosion of the fibrous sheath and invasion of the synovial sheath had occurred. In the other case in which involvement of the flexor tendon sheath occurred (Case 12) a rubber tube had been passed from the palmar surface to the dorsum of the hand between the third and fourth metacarpal bones. Not only was the fibrous tendon sheath eroded with a resulting tendon sheath infection, but the flexor tendons of the ring finger were divided by pressure erosion of the tube combined with the destructive action of the infectious process.



Fig 30 Photograph of the right hand Case 7 taken 30 days after the injury. The site of the injury is indicated by the granulating wound on the dorsum between the middle and ring fingers. The incision between the ring and little fingers was made for drainage of the subaponeurotic space. The volar view shows the incision made for drainage of the lumbrical canal and the incision made for drainage of the subaponeurotic space of the ring finger. Both views show the typical swelling of the proximal phalanx.

Although we have not seen a case in which a syphilitic infection was transmitted to the injured hand, this possibility, as is emphasized by the case reported by Owen, should not be forgotten. In one case (Case 10), in which the Wassermann reaction 4 weeks after the injury was negative, neosalvarsan was given intravenously but apparently without any helpful effect.

#### SUMMARY

Bite infections are frequently prolonged in their course and difficult to clear up because the infection is usually introduced deeply into the tissues through a comparatively small wound, because of the character of the infection, because of the anatomical arrangement of the structures involved, and because of the relatively low resistance of fascia, tendon, and bone to a mixed infection such as is caused by the organisms present in the mouth.

Such infections when introduced into the tissues of the dorsum of the hand—the most common site of inoculation—tend to spread to definite areas and this extension depends particularly upon the exact site and depth of the primary inoculation and upon the ease or difficulty with which the infectious material can escape to the surface.

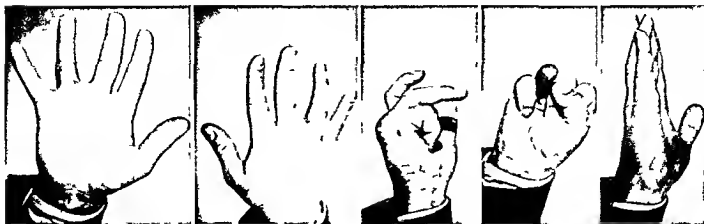


Fig 31 Photograph of right hand, Case 7, taken May, 1930. The incisions have healed, pain has disappeared and motion is returning.

In the treatment of such infections an exact knowledge of the sites to which infection tends to spread is of importance. These are in order of frequency, the subcutaneous space of the dorsum of the hand, the subfascial space of the dorsum of the proximal phalanx, the subaponeurotic spaces of hand and fingers which lie directly over metacarpal bones and proximal phalanges, the metacarpophalangeal joint, the fascial spaces of the palm and the flexor tendon sheaths. If these sites are kept in mind, extension of infection can be recognized early and accumulations of pus drained before extensive necrosis of tissue has taken place.

Unless such infections are drained early and adequately, bone, joint, and tendon involvement are certain to occur and to lead to extensive impairment of function.

#### RESUMÉ OF HISTORIES OF THIRTEEN CASES OF PATIENTS WITH HUMAN BITE INFECTIONS

**CASE 1** S F, Wesley Memorial Hospital, 141940 (December 15, 1928–December 26, 1928). Three weeks before admission to hospital the patient struck his fist against another man's tooth with a resulting wound over the metacarpophalangeal joint of the right middle finger. During the 2 days following the injury the hand became very swollen and painful, and the patient consulted a physician who made roentgenograms and ordered a salve and hot wet packs. A week later the dorsum of the hand was incised and hot packs were again ordered and continued for a week. A roentgenogram taken at this time showed joint involvement. The day previous to admission a small "pocket of pus" in the palm of the hand was incised.

On examination there was found a moderate swelling over the dorsum of the hand, especially over the metacarpophalangeal joint, where there

was an open discharging wound in which were two gauze drains. On the palm between the metacarpal bones of the middle and ring fingers there was an inch long incision in which there was also a gauze drain. Flexion of the middle finger was found to be impaired, otherwise movements of the hand were free. A roentgenogram (Fig 19) showed periostitis of the proximal phalanx of the middle finger with decrease in the joint space of the corresponding metacarpophalangeal joint. The drainage subsided rather promptly after removal of the drains and the application of hot, moist packs for a few days.

**CASE 2** R T, Wesley Memorial Hospital, 144030 (April 21, 1929–April 25, 1929). In November, 1927, the patient cut himself with a tooth brush across the dorsal aspect of the metacarpophalangeal joint of the right middle finger. The wound became infected and drained for about 5 weeks, but finally healed, apparently completely. In September, 1928, he accidentally bruised the palm of the hand. The injury was very painful, more so, he thought, than it should be. Considerable swelling developed and pus was thought to be present. In November, 1928, the palmar area was incised with release of pus. Drainage persisted for 3 days and subsided. Subsequently, however, the whole hand bothered him considerably. About 10 days before admission to the hospital the swelling of the hand recurred and the palm seemed to flatten out. He then consulted us and we advised hot soakings. As a result of this treatment the swelling subsided quite promptly, and there appeared a small yellow fluctuating area in the palm.

He entered the hospital April 21, 1929. A small scar could be seen on the dorsum of the hand over the metacarpophalangeal joint of the middle finger. In the center of the palm was a fairly superficial fluctuating area, just distal to the thenar eminence and lying over the third metacarpal bone. Close to it was a healed scar from an incision made 5 months previously. A slight amount of pus was released from the fluctuating area in the palm and the process healed rapidly after the application of hot, moist dressings.

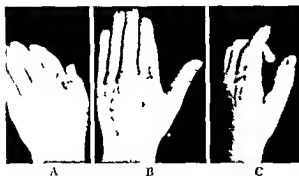


Fig. 32 Photographs of left hand Case 9. A. Photograph taken day previous to operation. There is swelling over the dorsum of the hand and thenar space. B and C. Photographs taken 7 weeks after the injury. The wound has healed. Movement is returning in the interphalangeal joints. The metacarpophalangeal joint is fixed in extension.

**CASE 3.** V. F. Wesley Memorial Hospital, 144410 (April 20, 1929-June 8, 1929). This man was admitted to hospital April 20, 1929, with an open lacerated wound over the metacarpophalangeal joint of the left index finger. He stated that he had fallen and cut his hand on a piece of tin. The wound was carefully cleaned and sutured by the house surgeon who told the man to return the following day for dressing. The day after the injury the dorsum of the hand was greatly swollen and painful. The patient had a temperature of 101.2 degrees and looked ill. All the stitches were removed and the man put to bed with hot moist packs over the hand and forearm. There were painful axillary glands on the affected side and it was assumed that we were dealing with a streptococcal infection. There was as yet no odor from the wound to excite our suspicion and we did not doubt the patient's story. In a few days a swelling developed in the thenar space. The wound was explored and the thenar space incised April 27, 1929. The wound over the metacarpophalangeal joint about 1 1/4 inches long was filled with unhealthy exuberant granulations and bits of necrotic tendon could be seen in it. At the base of this wound the roughened uncovered surface of the bones entering into the formation of the metacarpophalangeal joint could be felt. There had been an extension of pus into the space between the index and middle fingers. No connection could be found between the dorsal wound and the thenar space though the joint space was not explored. The thenar space was opened along the radial border of the second metacarpal and about one and one half ounces of stinking yellow pus evacuated. The original wound was also enlarged and the cleft between the index and middle fingers incised. On obtaining the foul smelling pus we at once realized we were dealing with a human bite infection and the patient admitted this later.

Hot, moist dressings were reapplied and the man's temperature came down rapidly to normal. After some two weeks, however, it was apparent that

drainage was not adequate. There was still very abundant malodorous drainage, and occasional rises of temperature. A roentgenogram (Fig. 20) made of the hand showed considerable erosion and destruction of the joint and head of the metacarpal. May 14, 1929, the original incisions were enlarged, the joint space curetted, and considerable necrotic bone removed. From this time on, despite heat and the use of Dakin's solution, the destructive action of the infection on the bone progressed. A roentgenogram May 27, 1929 (Fig. 21) showed considerable infection of the bone and joint. The joint surfaces were practically destroyed and there was considerable periostitis of the shafts of the bones. Culture of the wound made at this time showed a growth of *Bacillus proteus vulgaris* (Hauser).

The best procedure at this time would undoubtedly have been amputation of the finger. The dead bone, however, was resected and the wound healed promptly, but the patient was left with a flail finger which will undoubtedly require amputation.

**CASE 4.** F. R. Passavant Memorial Hospital 101 (June 26, 1929-June 29, 1929). Ten days previous to entrance to the hospital the patient struck another man in the mouth and received a slight wound on the dorsum of the right hand just distal to the metacarpophalangeal joint of the index finger. He put mercurochrome on the wound and applied a dressing. Everything seemed all right until he accidentally struck the finger at which time it swelled and became painful. On admission to the hospital there was a small open wound just distal to the joint, with very slight non-odorous purulent discharge. The dorsum of the hand was much swollen and there was a red streak running up the forearm. No glands were palpable in the axilla. The application of hot moist dressings resulted in prompt subsidence of pain and swelling. It was several weeks, however, before the wound finally healed.

**CASE 5.** B. L. Passavant Memorial Hospital, 434 (September 3-October 7, 1929). Eleven days previous to admission to hospital the patient struck a man on the mouth receiving a deep gash over the third metacarpophalangeal joint of the right hand. He was seen at once by a physician who applied iodine and strapped the wound tightly with adhesive. On the next day the hand became red and swollen and he was seen by Dr. L. H. Hines who applied hot moist packs. Pus began to drain from the wound 2 days later and he was taken to a hospital where the wound was enlarged for better drainage. After this procedure he obtained relief for several days but subsequently the swelling and pain recurred with such severity that he was unable to sleep. At Dr. Hines' request he was then admitted on our service at Passavant Memorial Hospital.

On admission he had a ragged, discharging foul smelling wound over the dorsum of the third metacarpophalangeal joint of the right hand. There was considerable general tenderness over the whole



Fig. 33 Case 11, three weeks after bite injury of right index finger

finger, not limited to the tendon sheath, and it was possible to extend the fingers without pain. The epitrochlear glands were enlarged and painful, but there were no red streaks of lymphangitis. The temperature at time of entrance was 98.4 degrees and it did not rise above 99 degrees during his 2 weeks' hospital stay. Blood examination made at the time of entrance showed a red count of 4,800,000, hemoglobin of 80 per cent, a white count of 10,700, with 61 per cent polymorphonuclear neutrophils, 35 per cent lymphocytes, and 4 per cent transitional cells.

Hot packs were applied for 2 days with alleviation of pain and decrease in the amount of discharge, after which dressings moistened with Dakin's solution were applied for 5 days. The discharge diminished, but it was evident that drainage was not adequate, there was some tension in the palm, and it was thought wise to secure better drainage. This was done August 31, through an incision on the dorsum along the ulnar side of the third metacarpal bone. Considerable pus and granulation tissue were removed. Because of the palmar tenderness the middle palmar space was opened in the cleft between the middle and ring fingers. No pus was found, though there was considerable edema and thin yellowish fluid. A Carrel tube was placed in the dorsal wound and the use of Dakin's solution continued. Cultures made from the pus showed a profuse growth of various organisms, a large and small coccus and a bacillary form being the most prominent. Anaerobic cultures were not made.

From this time on improvement was steady but slow. During convalescence a collection of pus found its way to the surface on the radial side of the proximal phalanx of the finger. This drained for a few days and ceased. A roentgenogram (Fig. 22) showed an obliteration of the joint space, atrophy of the bones, and slight periostitis of the metacarpal and the proximal phalanx. On one occasion, several weeks after discharge from the hospital, the region over the metacarpophalangeal joint became red and fluctuant. Simple stab incision into the center with release of a small amount of pus resulted in prompt healing.

CASE 6 T. B., Northwestern University Surgical Dispensary, 22718 E. On September 6, 1929, one month previous to his admission to Northwestern

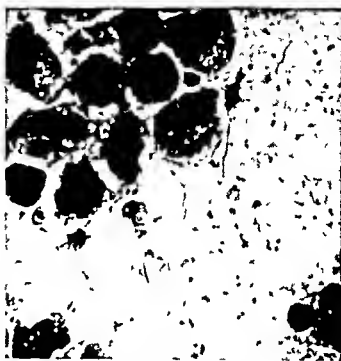


Fig. 34 Photomicrograph of the pus from Case 11. Original magnification circa 1,500. There are numerous pus cells among which are seen spirilla and fusiform organisms.

University Surgical Dispensary, the patient, a man of 24, struck a man on the mouth and received a wound over the dorsum of the metacarpophalangeal joint of the right middle finger. The wound was sutured at a hospital, where he did not reveal the true nature of his injury. The hand became very much swollen and painful. On the following day the wound was reopened, and hot, moist dressings were applied. A moderate discharge developed, which, however, cleared up in 2 or 3 weeks. He applied to the dispensary for treatment, October 9, 1929, because the hand had become very stiff from long immobilization. At this time a diagnosis of involvement of the third metacarpophalangeal joint was made and a roentgenogram made (Fig. 23). Physical therapy was instituted to mobilize the interphalangeal and metacarpophalangeal joints.



Fig. 35 Case 11. Osteomyelitis and suppurative arthritis have led to a pathological dislocation at the distal interphalangeal joint.

We first examined the patient November 3, 1929. At this time there was a hard swelling about the third right metacarpophalangeal joint with redness and blanching on pressure. The interphalangeal and metacarpophalangeal joints of all the fingers showed definite limitation of motion presumably due to fibrous thickening of the joint capsules. The roentgenogram taken some time previously showed an arthritis with destruction of cartilage of the third metacarpophalangeal joint (Fig 23). The roentgenologists suggested that there was probably bony ankylosis.

Physical therapy was continued, but it was advised not to massage or move the involved joint. On December 21, 1929 a swelling had developed over the dorsum of the joint with an area of fluctuation in the center. This was incised and a moderate amount of pus was released. An aerobic culture of this pus resulted in a pure growth of staphylococcus. The inflammation responded rapidly to hot moist dressings. Physical therapy was again instituted in January. On February 1, 1930 he returned with a second swelling in the same location as the first. This was incised and anaerobic cultures were made. The swelling receded rapidly after the application of heat. The cultures remained sterile even after a week's incubation.

Movements were gradually improving in the hand and on February 8 a tension splint was applied to assist in obtaining extension of the fingers. A roentgenogram (Fig 24) made at this time showed that the density of the third metacarpal had returned to normal. There was no evidence of active infection at this time. The man returned on March 1, 1930 with a third swelling of the hand in the same location as the previous two. He had worn the splint for 24 hours and believed that pressure of the dorsal plate on the injured area had caused a flare up. This area was again incised with release of pus from which anaerobic cultures were made. Hot wet packs were applied and in a week the inflammation was gone. The anaerobic cultures from this pus showed after 6 days a pure culture of fusiform bacilli (Fig 25).

The man was seen again early in May, 1930. He had been back at his work as a painter for some 6 weeks and had good use of the hand. The movements in all but the middle finger had returned to normal. In the middle finger flexion and extension of the interphalangeal joints were normal, but there was still some limitation of motion in the metacarpophalangeal joint (Fig 26) the range of movement being from 180 degrees extension to 135 degrees flexion. The patient was again seen on August 2, 1930. He had had no trouble with the hand until 3 days previously when following a hard day's work the dorsal swelling recurred with considerable throbbing pain. He applied hot, wet packs for 3 days and came to the dispensary when he believed incision was indicated. At this time the whole dorsum of the hand was red and swollen and there was a point of localized tenderness just to the ulnar

side of the midline of the metacarpophalangeal joint of the middle finger. No fluctuation was present and it was not thought advisable to incise at the time. On August 4 the man was given 0.6 gram of neosalvarsan and on August 6 an incision was made and about 3 cubic centimeters of dark flocculent pus was released from beneath the extensor tendon. Smears from this pus failed to reveal any organisms.

CASE 7. F. H. F., Passavant Memorial Hospital, 1573. A policeman of 38 years, was bitten by a negro on the dorsum of the right hand in the space between the middle and ring fingers on January 12, 1930. The wound was treated at once by a physician who applied antiseptics and packed the wound with gauze. The hand was swollen somewhat the following day and there was slight drainage on the second day following injury. On January 15, the hand became intensely swollen and painful and he was admitted to Passavant Memorial Hospital at 9 p.m. At the time of admission there was an open draining wound on the ulnar side of the middle finger at the level of the head of the metacarpal. The epitrochlear glands were enlarged. The temperature was 101.2 degrees F.

Further drainage was instituted at once. The original wound on the dorsum was enlarged and considerable foul pus poured into it from the interdigital space between the ring and little fingers. This space was then drained directly by a longitudinal incision immediately over it. There was rather profuse hemorrhage from several large subcutaneous veins which were divided in the incision. Massive hot, moist packs were applied. Immediately following the operation the patient suffered a chill which lasted 15 minutes. A culture taken from the pus at this time was reported to contain staphylococcus albus and aureus.

Following drainage the temperature dropped to 99.4 degrees F., the swelling decreased and the pain practically disappeared. That the process was not brought to a standstill was shown by the fact that the malodorous drainage persisted and by the daily rise in temperature to 101-101.4 degrees F. On January 22 swelling and tenderness on the volar surface of the hand over the metacarpophalangeal joint of the ring finger were first noted. There was considerable pain on extending the finger and a point of tenderness was present in the lumbrical space between the ring and little fingers. The question of tendon sheath involvement was considered but the localization of pain to the joint on extension of the finger pointed rather to involvement of this structure as the source of the pain.

On January 22 the lumbrical swelling was incised. Pus was found extending palmarward from the dorsal infection. The tendon sheath of the flexor tendons of the ring finger was edematous and gray. Massive hot, moist packs were again applied.

The following day there was still considerable pain on extending the ring finger. We feared that the sheath was infected but felt that if it were not already infected it surely would be if it were opened.

and that if it were already involved the chances of saving the tendon would be slight even if the sheath were adequately drained. It was decided, therefore, not to open the sheath. The white count on January 24 was 10,100 with 74 per cent neutrophils.

The pain on extending the finger gradually diminished, but although the temperature dropped after the drainage of January 22 it again rose and on January 29, a fluctuant swelling appeared over the radial side of the proximal phalanx. The white count at this time was 14,750. The swelling was incised and grayish green, foul smelling pus was evacuated. At the same time, the incision over the fourth lumbrical canal was lengthened and opportunity taken to examine the tendon sheath again. The outer fibrous sheath was oedematous, but it was not thought that there was pus within it. It was not opened. Forceps were passed into the incision between the third and fourth metacarpals and bare bone was felt. Smears taken from this pus showed a few fusiform organisms and an occasional spirillum.

On January 31, the white count had dropped to 11,700 and from that time on the temperature remained about normal. The hot moist packs were continued until February 2, when they were replaced by Carrel Dakin treatment. The swelling over the proximal phalanx receded somewhat, but failed to disappear completely. Pressure over it and over the metacarpophalangeal joint led to exudation of yellowish gray pus from the palmar incision. A roentgenogram on February 4 (Fig. 27) showed some destruction of the distal end of the fourth metacarpal bone as well as some damage to the fourth metacarpophalangeal joint. The white blood count was still increased slightly, to 11,900.

On February 6, a small incision was made over the palmar surface of the proximal phalanx of the ring finger and pus and necrotic tissue were evacuated. Hot, moist packs were again instituted. A smear taken from the pus at this time showed a highly motile coarse bacillus, unidentified, and culture showed staphylococcus aureus, bacillus mucosus capsulatus and streptococcus salivarius. No spiral forms were visible on dark field examination.

The day following this operation the white count was 14,200, but the temperature was not above 99.2 degrees F and the condition gradually improved. Dr. A. A. Dav of the Department of Bacteriology, Northwestern University Medical School, made another culture from the wound and secured a pure growth of streptococcus salivarius.

On February 11 the temperature reached normal. The swelling slowly decreased, but still remained most marked over the metacarpophalangeal joint and proximal phalanx of the ring finger (Fig. 30). The white count February 11 was 10,950.

By February 22 all incisions were beginning to heal, there was still some discharge, but it was much less offensive and the granulations were becoming less oedematous. The patient was discharged from hospital February 22.

On February 25, a roentgenogram (Fig. 28) revealed a definite osteomyelitis involving the distal end of the third metacarpal and the proximal end of the proximal phalanx of the ring finger.

The patient was seen daily for several weeks, and then at intervals until May 15. Discharge persisted from the dorsal incision at the original site of injury for some 2 weeks, and for almost the same time from the palm. The incisions, however, healed slowly. Some 3 weeks after discharge from hospital a small fluctuant area over the volar surface of the metacarpophalangeal joint was incised without anesthesia. A small amount of necrotic fat was released. This incision healed almost immediately.

A roentgenogram made April 12 (Fig. 29) showed evidence of progress toward cure. There were periosteal thickenings both in the fourth metacarpal and proximal phalanx of the fourth finger and some evidence of damage in the joint as well, but in the judgment of the roentgenologist, Dr. James T. Case, the process was subsiding.

The man was last seen May 15. At that time he was developing movement of the finger (Fig. 31), and the decision with regard to incision of the tendon sheath appeared to have been vindicated.

CASE 8 E. B., Cook County Hospital, 1143085 (November 30, 1929-December 14, 1929). One week previous to entrance into hospital the patient, a man of 31 years, struck another man on the mouth and split open the skin over the knuckle of the left index finger. He paid no attention to the wound until 2 days later, when because of the pain he began to soak the hand in boric acid solution. He continued this treatment for 2 days without relief, and then went to a physician who trimmed the edges of the wound, removed some black material from it, and ordered hot boric acid soakings every 2 hours. These were kept up for 3 days, but because no improvement took place his physician advised him to go to the Cook County Hospital for treatment. (We are indebted to Dr. Edward Lyon, Quincy, Illinois, at that time senior surgical interne at Cook County Hospital, Chicago, for the careful record made of this case. The patient was also presented by him at the December meeting of the Cook County Hospital Surgical Society.)

At the time of admission to the hospital the temperature was 101.6 degrees and the pulse 140. There was a sinus over the dorsum of the metacarpophalangeal joint of the left hand, from which a greenish-yellow thick, stinking pus exuded (Fig. 32). The tissues over the thenar space were tense, red and swollen, there was considerable swelling of the dorsum of the hand and impairment of flexion of the metacarpophalangeal joint of the finger. There was no lymphangitis or lymphadenopathy. Hot boric packs were ordered and a roentgen examination of the hand requested. Two days after admission it was evident that further drainage was required and on December 3, 1929, the wound on the dorsum was enlarged. Some necrotic tendon was excised and the thenar space was opened from its palmar sur-



face. Considerable pus was released from the dorsum, but none from the thenar space. The temperature just before operation had reached 103 degrees. Cultures made from pus revealed a mixed infection of hemolytic streptococcus, staphylococcus albus and bacillus coli. Hot boric dressings were again applied and kept up for 2 days after which Carrel Dakin treatment was instituted. The temperature dropped to 101 degrees the day following operation and reached 100 degrees the second day after which it remained normal. A week following operation a small abscess or extension of the original process appeared on the finger. This was reached with a pair of forceps through the original incision and was drained.

A roentgenogram made December 16, 1929 showed an osteomyelitis of the bones forming the metacarpophalangeal joint.

The man was discharged 2 weeks after admission and reported duty for dressings. Healing took place slowly but was complete 4 weeks after his discharge from the hospital. Before healing was complete physical therapy was begun and when last seen the patient was able to extend his finger completely and to move it fairly well at the interphalangeal joints. At the metacarpophalangeal joint, however, there was almost complete fixation in extension (Fig 32).

CASE 9. G. L. Cook, County Hospital 1001536 (February 3 1927-March 16 1927). A laborer, aged 51 years, was bitten on the left thumb by a woman 4 days previous to his admission to the Cook County Hospital. The wound was washed in cold water and Sloan's liniment and arnica and iodine were applied. Two days later the thumb became very painful on movement and throbbing pain developed on the right side of the wrist. At the time of admission to the hospital 4 days after the injury there was a swelling of the thumb and wrist more marked on the dorsal surface and slight oozing of serous fluid from the wound edges. The axillary lymph glands were somewhat enlarged and sugar was present in the urine. The day following admission the thenar space was opened widely by an incision on the dorsum of the hand and hot, wet dressing applied.

Following the institution of drainage the patient felt somewhat better but the temperature remained elevated and ranged between 100 and 102.8 degrees F. Despite the continuous application of hot packs and the forced administration of fluid the pain returned in the hand and arm, the forearm and arm became red and very much swollen and the senior interne on the service Dr. Oscar Richter noted crepitation extending over the forearm. The pus from the draining wound was described as having a "terrible odor."

Three days after the first operation we were asked to see the patient. At that time the tissues about the drainage incision had become black and the edges had separated widely. There was an extensive moist gangrene of the subcutaneous tissues

and extensor tendons, with a profuse fecal smelling, brownish black discharge. The entire forearm was dusky, hot and tense. Several long incisions from the wrist to the elbow were made immediately, Carrel tubes were inserted and treatment with Dakin's solution was instituted.

There seemed to be some relief from the toxic symptoms as a result of the drainage but it was only temporary. Although the temperature did not again rise over 101.2 degrees F. the patient became very toxic, and 2 days after the second operation developed a hiccup which persisted with little respite. Four days following the second operation it was obvious that the infection was still spreading upward and would soon prove fatal if not arrested. Under nitrous oxide anesthesia the arm was rapidly amputated midway between the elbow and shoulder. Although there was a very extensive infiltration and gangrene of all the subcutaneous tissues of the forearm and lower one half of the arm the muscles at the site of amputation were red and healthy, and apparently not involved in the infectious process.

Following the amputation the man made a slow, but steady recovery which was hampered somewhat by his diabetic condition. He was discharged March 16, forty-one days after admission, with a granulating wound over the stump of the arm.

The condition of the hand and forearm in this case very closely resembled the excellent photograph of a similar case reported by Dr. John H. Flick.

CASE 10. H. W., Cook County Hospital, 1111948, 1112416, 1117638 (April 13 1929-April 16, 1929; April 16 1929-May 20 1929, May 20 1929-July 27 1929). This man, a police officer, was admitted to the observation ward of Cook County Hospital April 13, 1929 shortly after being bitten on the dorsum of the third right metacarpophalangeal joint by a drunken patient.

He was seen at the time of entrance by Dr. Roger Vaughan who confirmed the examining room diagnosis of suppurative arthritis and ordered continuous hot boric packs applied to the hand. The temperature at this time was 100 degrees F. and the man complained of considerable pain in the hand. For the next 2 days the hot packs were kept up, but the pain was not relieved and the man was transferred to our service on April 15, 1929.

At that time there was a draining sinus on the dorsum of the right hand just radial to the middle metacarpophalangeal joint. There was also considerable swelling of the entire dorsum of the hand. The patient's temperature was 102 degrees F. Under nitrous oxide anesthesia a vertical incision was made just radial to the extensor tendon of the middle finger. Considerable thick foul pus was released from under the tendon and dorsal aponeurosis, and oozing of pus was observed from a small opening in the joint capsule. Voluminous hot moist boric packs were applied. On the following day the temperature dropped to 100 degrees F. and at no time afterward did it rise over 101 degrees, within a week it had reached normal.

On April 17, 1929, the oedema had subsided considerably though there was considerable foul drainage and subcutaneous necrosis still present in the wound. The hot moist packs were kept up until April 19 at which time Dakin's solution was applied, at first as a continuous drip and later for saturating the dressings, which were changed twice daily. The pain in the hand subsided slowly with a tendency to occasional exacerbations but not of the original severity. As the swelling subsided the edges of the wound became covered with large exuberant granulations from the center of which thick green pus exuded.

On May 6 marked tenderness on movements of the middle finger was still present. There was also slight tenderness on the palmar surface of the metacarpophalangeal joint. It was thought at this time that osteomyelitis was developing and that there was probably some necrosis of the extensor tendon of the middle finger. A roentgen ray examination made May 13, revealed a destructive process of the proximal end of the first phalanx of the right middle finger and distal end of the third metacarpal. Although the patient's Wassermann reaction was negative he was given three injections of neosalvarsan by the senior interne, Dr. Philip Shapiro, with the object of combating spirillum infection (Pilot and Meyer).

On May 24, the palmar tenderness of which the patient had complained from time to time became definitely more marked and an area of palmar discoloration and swelling concerning the presence of which there had been some doubt, became definitely apparent. Three days later under nitrous oxide anesthesia an incision was made into the middle palmar space on a line with the cleft between the middle and ring fingers. Not only was there pus in the middle palmar space, but the infectious process had eroded the fibrous flexor tendon sheath as well and was extending distalward within the flexor sheath.

In spite of wide incision and drainage of the tendon sheath the flexor tendons subsequently became necrotic and the palmar wound continued to drain until the necrotic tendons were removed.

A roentgenogram made June 17, showed a definite osteomyelitis involving the terminal phalanx of the right middle finger and corresponding metacarpal and a destructive arthritis between the third metacarpal and the first phalanx.

On July 27, 1929 the patient's wounds were completely healed with the finger fixed by bony ankylosis at the metacarpophalangeal joint and slightly flexed at the interphalangeal joints. Movement at the latter joints was of course impossible because of the loss of the flexor tendons.

CASE 11 C. C., Cook County Hospital, 1157234 (March 4, 1930-March 31, 1930). Three weeks previous to admission to the Cook County Hospital the patient, a woman of 25 years, was bitten by another woman on the right index finger. Shortly afterward the finger became swollen and painful and

despite home remedies the infection became gradually worse.

On admission there was noted a marked swelling of the dorsum of the middle phalanx of the right index finger (Fig. 33). Along the lateral side of the finger were several sinuses discharging a grayish-yellow pus of extremely foul odor. The finger was only moderately tender and flexion and extension caused only moderate pain. The temperature at this time was normal and at no time during her hospital stay did it rise over 99.6 degrees F. Smears taken from the pus (Fig. 34) showed spirilla and fusiform bacilli along with numerous cocci and bacilli and many pus cells. There were seen a few round bodies with double contoured membrane and clear cytoplasm, but no mycelia or yeast forms. Peroxide dressings were applied and a roentgen examination was requested. This revealed an osteomyelitis of the distal half of the second phalanx and proximal half of the terminal phalanx (Fig. 35). The blood Wassermann was negative. A laboratory culture from the wound showed a hemolytic staphylococcus.

Four days after entrance into hospital the finger was opened by crucial incision and material for biopsy removed. This showed a non specific inflammation.

Eleven days following her admission to the hospital she was seen by us in consultation. Carrel Dakin treatment and careful attention to the prevention of reinfection was advised before considering the question of amputation. Under Dr. L. Cardon's care the finger continued to improve and the patient was discharged on the twenty-seventh day with a granulating wound still present, but with the infection well under control.

CASE 12 J. V., Michael Reese Hospital, 96775 (March 25, 1928-April 28, 1928). Three days before admission to hospital March 25, 1928, the patient, aged 26 years, was set upon by three men and in the ensuing fracas struck one of them in the mouth with his right fist. There was considerable bleeding from the resultant wound. Immediately after the fight the hand was washed in hot water and boric acid solution and mercurochrome applied. Three hours later when in bed the patient noticed the pillow was soaked with blood and the hand considerably swollen.

The following day he consulted a physician who washed the wound, applied mercurochrome and dressed it. In the evening he was taken to a hospital and hot, wet dressings were applied to the hand. Because he was dissatisfied with the treatment he left the hospital the following day, and went to a physician who enlarged the wound and removed a considerable amount of old blood from beneath the subcutaneous tissues of the dorsum of the hand. Before the incision was made the patient had a severe chill lasting about 5 minutes.

On the morning of admission to the Michael Reese Hospital the patient had more chills during one of which he became cyanotic.

On admission at 11 a.m., March 25 his tempera-

ture was 103.2 degrees F, his pulse 100, and respirations 20. A blood examination showed hemoglobin of 85 per cent and a white count of 14,700. The urine examination showed a trace of albumin. The Wassermann and Kahn tests were negative. The hand was described as markedly swollen and painful.

From March 25 to April 5 active antiseptic treatment was carried out. The hand was soaked for 15 to 30 minutes once or twice daily in a 1:10,000 mercuric chloride solution. Between soakings hot boric dressings were applied and irrigations with Dakin's solution or mercurochrome were carried out three or four times daily. Once each day a gutta percha drain was removed and another inserted. The patient's temperature ranged between 98 degrees and 102.4 degrees F.

April 5 a roentgenogram was made and a report of "negative for osteomyelitis" returned.

April 6 the urine showed acetone and a trace of albumin. On the same day an incision was made on the palmar surface of the hand from the middle of the palm distally to the ring finger. Necrotic tissue and loose cartilage from the head of the fourth metacarpal bone were removed and a rubber tube was inserted between the third and fourth metacarpal bones through the hand from the palm to the dorsal surface. April 10 the patient's temperature reached normal and remained normal thereafter although the swelling, pain and wound discharge continued without abatement. April 14 the dorsal incision was enlarged under local anesthesia.

On April 18, when we first saw the patient, the hand was markedly swollen and painful, there was a profuse foul discharge from the palmar and dorsal incisions and there was marked tenderness over the flexor tendon sheath of the ring finger. This finger could not be moved actively. Under nitrous oxide anesthesia the wounds were explored. When the rubber tube was removed and the middle palmar space was exposed it was seen that the flexor tendons of the ring finger were completely divided with a loss of one half inch of the tendons. The synovial sheath distal to the point of division was filled with pus. The head of the fourth metacarpal was necrotic and forming a sequestrum.

The tendon sheath was widely opened by a lateral incision, the necrotic head of the fourth metacarpal removed and the wound lightly packed with petrolatum gauze. Continuous warm wet boric dressings were applied for 48 hours, on the third day Carrel tubes were laid in the wounds and the tubes were irrigated every 2 hours with Dakin's solution.

Recovery was slow but uneventful. April 28, 10 days after the last operation, the patient left the hospital, and the wounds were completely healed. May 15. At the time of healing passive movement was possible at the fourth metacarpophalangeal joint but active flexion of the ring finger was impossible because of the division and partial loss of substance of the flexor tendons of the finger.

CASE 13. C. D., Northwestern University Surgical Dispensary, 29036 (June 11, 1930). This patient a

young man of 26 years was held up on the evening of June 8, 1930, and while struggling struck his right fist against the assailant's mouth and received a lacerated wound over the proximal interphalangeal joint of the right finger. A few hours later the wound was treated by a physician who sutured the skin and applied a splint to the finger. Early the next day, but a few hours following the injury, the hand began to give him considerable pain and became swollen. This discomfort persisted until June 11 when it became so severe and of such a throbbing intensity that he came to the Northwestern University Surgical Dispensary for relief. At the time of admission the patient's temperature was 100.6 degrees F, the dorsum of the right hand and the ring finger were markedly red and swollen and the epitrochlear glands were palpable and tender. The sutures were removed from the wound, with a resulting discharge of pus, and hot, wet dressings were applied.

On June 12 the temperature was still elevated (100.4 degrees F) the redness and swelling had diminished somewhat but there still was considerable discharge. On June 13 the temperature at the time of his visit to the dispensary was 99.4 degrees F, the swelling had diminished considerably and the glandular enlargement had disappeared. The hot dressings were continued for another 24 hours.

The general edema of the hand had subsided by June 16 and did not return thereafter, but discharge from the wound over the proximal interphalangeal joint persisted. When the finger was moved a definite grating was heard in the joint.

A roentgenogram made June 18 showed some increased density of the middle phalanx suggestive of a periostitis. The man was advised to soak the hand twice daily in hot sterile water and under this treatment the swelling and discharge receded but never entirely disappeared. From time to time the wound would close, redness, swelling and pain would appear and persist until drainage was again instituted.

July 16 the patient went swimming with a resulting flare up of the infection and increased swelling and redness. Hot packs applied for 24 hours resulted in diminution of the acute symptoms though the discharge persisted. A roentgenogram made July 17 showed nothing different from the previous examination.

He was first seen by us on August 2 at which time there was a marked indurated swelling about the proximal interphalangeal joint which was held at an angle of about 160 degrees. Motion in the joint was possible through an arc of about 15 degrees. The wound was entirely closed and there had been no discharge for several days. The man was advised to continue with hot soakings of the hand twice daily and to report back to the dispensary at once should an acute swelling develop. An anaerobic culture was requested if at any time the wound should discharge. On August 7 swelling again occurred and a fluctuant area developed on the

dorsum of the joint. This ruptured and a moderate amount of pus discharged from the wound. Unfortunately, due to an oversight, a culture was not procured. On August 9 the swelling had receded and the discharge had ceased. Anaerobic cultures were made from the granulating surface but no growth resulted. On August 15 the swelling and pain reappeared and the man was sent from the dispensary to St Luke's Hospital on the service of Dr C G Shearon. Dr Shearon made a large incision through the area of swelling and fluctuation. A localized focus of pus was evacuated and tissues about the joint and bones were seen to be markedly oedematous. Hot moist packs applied for several days lead to a rapid abatement of the pain and swelling. Cultures made of the pus yielded a haemolytic streptococcus and an unidentified gram negative bacillus which was not bacillus fusiformis. The patient was discharged from St Luke's Hospital and reported back to the dispensary for observation. He was last seen August 30 at which time the incision had healed, the swelling about the joint was slowly receding and the joint could be moved a few degrees without pain.

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## TUMORS OF THE PAROTID GLAND

## A STUDY OF TWO HUNDRED AND TWENTY FIVE CASES WITH COMPLETE END RESULTS IN EIGHTY CASES

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THIS report is based on a study of 225 cases of parotid gland tumor, taken from the records of the Massachusetts General Hospital and the Collis P. Huntington Memorial Hospital. As the cases date back to 1872, many of them are incomplete in respect to pathological report or follow up data and such cases have been excluded except in the very general summaries as to sex, right or left side, etc. In 80 cases, however, the records are complete, including pathological report and follow up. In most of these cases we have personally studied the microscopic slides and in all doubtful ones have consulted with Dr. Fracy B. Mallory, pathologist to the Massachusetts General Hospital to whom we are much indebted for his valuable assistance.

## ETIOLOGY

There has always been dispute as to the origin of mixed tumors. By mixed tumors we mean benign growths of varying histological structure, as distinct from carcinomata and sarcomata. Lwing summarizes our knowledge of their origin as follows: "(1) The endothelial origin has been disproved. (2) No single source of the mixed tumors meets all the requirements. Some are distinctly adenomatous, and probably arise from the acini and ducts of the gland in which they are well incorporated. Others are encapsulated or extraglandular and take the form of basal cell or adenoid cystic epithelioma. These probably arise from misplaced and, occasionally, embryonal portions of gland tissue. Branchial remnants may possibly be connected with this group. (3) The derivation of mucous tissue and cartilage from gland epithelium has been satisfactorily proved, and there is no necessity of including in the originating tissue any cartilaginous structures."

In discussing complex tumors of the salivary glands, Wood writes as follows: "There is a peculiar group of tumors which occur in the salivary and lacrymal glands, in the palatal region, in the lips, and occasionally elsewhere, all of which have similar structure and are not closely related in morphology with any of the well known types of tumors. They are considered under the fibro-epithelial group, though as they probably arise chiefly from malformations and displacements during embryonic life, they are by many authors classed with the teratoid tumors."

Fry has recently studied the pathology of a series of mixed tumors with reference to their structure and origin. He concludes: "(1) The so called mixed tumors of the salivary glands are not in reality mixed, but are entirely epithelial in origin. They are in most cases derived from the ducts of the gland, but occasionally arise from the secreting cells. (2) The mucinous material which is such a prominent feature of most of these tumors is a true secretion of mucin by the tumor cells, and this is only an exaggeration of a normal function of the gland cells. (3) The tumors do not contain cartilage. In the substance which has been described as cartilage, the matrix is formed by a change in the mucin of the tumor, whereby it loses its fibrillar appearance and its power of staining deeply with mucicarmine, the cells are epithelial cells. (4) Some of the tumors show varying degrees of malignancy, there is no definite dividing line between the innocent and malignant, and some of the more malignant may show many of the features typical of the innocent type of tumor."

We have studied the subject from a clinical rather than a pathological standpoint and cannot add anything to the theories mentioned as to the origin of mixed tumors. Trauma as a possible etiological factor has

been considered unimportant by most present day observers. In our series there was a history of trauma in only 6 cases, most of which were mixed tumors. In 2 other cases the tumor followed mumps. In one carcinoma case the tumor appeared soon after the patient was kicked in the parotid region by a horse. In 9 cases there was a history of cancer in the family. Many of the cases in this series may not have been questioned as to trauma or as to family history of cancer, in any event, the percentages of traumatic origin or familial cancer must be low, and we do not believe that these are factors of great importance in the etiology of parotid tumors.

#### PATHOLOGY

Ewing classifies all tumors of the salivary glands under the heading of epithelial tumors, and divides them into three groups, as follows: (1) benign adenoma, (2) malignant adenocarcinoma or carcinoma, and (3) autochthonous mixed tumors.

"Adenoma of the salivary glands is rare. In none of our series was the diagnosis of adenoma made. McFarland (6) has recently reviewed many cases of supposed adenoma of the salivary glands and says in conclusion: 'The newly reported case with which this contribution opens is probably as much like adenoma and as much like a salivary gland as any, but, as was pointed out, is really very little like either.' The same seems to be true of all. Upon careful comparison with the gland itself, very little resemblance can be found, and one remains in doubt whether real adenoma of the salivary glands occurs. If so, it must be very rare, for there can be but little doubt that nearly all, if not, indeed, all, of the described adenomata are but mixed tumors of unusual appearance." Certainly our experience is in accord with that of McFarland. To continue with Ewing's classification—

"Carcinoma. Pure malignant epithelial tumors of the salivary glands are by no means rare. The carcinomata usually develop rapidly, and while at first they may be encapsulated, they soon invade the whole gland, the capsule, and regional nodes. After extirpation, prompt recurrence is usually

observed. In advanced cases there are local and general metastases, and in Nasse's case many bones were involved." Our carcinoma cases as a rule recurred soon after operation, invaded the glands of the neck, and in 2 cases metastasized to the lungs. We have in our series no record of distant metastasis other than these two to the lungs.

Mixed tumors are classified by Ewing as follows: (1) myxochondrocarcinoma, (2) basal cell carcinoma with hyaline stroma, (3) adenoid cystic epithelioma.

We have always regarded mixed tumors as benign and find the use of the term carcinoma, as applied to mixed tumors, somewhat confusing. Malignant tumors in our series have all been classified as either carcinoma or sarcoma, although it has been recognized that many of them contain a great variety of tissues. Ewing has little to say about sarcomata of the parotid, apparently feeling that they represent recurrences, for he says, "spindle cell, round cell and perithelial sarcomata have been observed after extirpation of chondrocarcinoma, and it seems probable that most of the so called sarcomata of the salivary glands are atypical epithelial growths (Menetrier, Chevassu, Wood). Rarely these large cell sarcomata are pigmented, but they lack the malignancy of true melanoma." We have a number of cases which we believe to be primary sarcoma of the parotid—one of them a melanotic sarcoma (T. B. Mallory). This case bears out Ewing's statement as to their relatively benign character, for it occurred in a woman of 49 years (Case 71), who lived 9 years after the growth was excised, dying of pulmonary infarct and chronic cardiac disease. Whether this patient ever had any recurrence after operation is not known, as the only subsequent information obtainable was the record of her death. Clinically, it was probably not very malignant, for the operating surgeon records having developed a capsule, and the pathologist describes the specimen grossly as "a cherry-sized cyst, purplish red, with soft center."

The term mixed malignant tumor has not been used in this series, as it has seemed possible to classify all malignant tumors as either carcinoma or sarcoma. There prob-

ably are, however, certain tumors that can not be so definitely classified, but we believe they are not common

#### OCCURRENCE

*Age* Parotid tumors may occur at any age, the youngest patient (Case 21) having been only 9 years old at the onset of its growth, which proved to be a mixed tumor, and the oldest patient (Case 53) having been 72 years of age at the time of onset of a carcinoma

Benign tumors are more apt to begin before the age of 40, whereas malignant tumors usually begin after the age of 40 Table I shows the age of onset in 167 cases

*Sex* Tumors of the parotid are almost equally divided between the sexes, in our series there being a slight preponderance of males, 110 males to 93 females In the 80 cases with a positive pathological diagnosis, however, there are 2 more females than males

*Right or left side* McFarland has found parotid tumors more common on the left side, but in our series, out of 161 cases, 83 were on the right side, and 78 on the left

#### SIGNS AND SYMPTOMS

The diagnosis of parotid tumor is usually easy but to differentiate clinically the benign from the malignant is difficult and often impossible

*Duration* In 38 mixed tumor cases the average duration of the tumor before entering the hospital was slightly over 7 years The longest duration was in a woman of 48 years (Case 10), who said she had had the tumor "always" Only 2 patients had had the tumor for less than 1 year In 30 cancer cases the average duration of the tumor was 4½ years, the longest duration being 30 years (Case 73) There were, however, 14 patients, who had had symptoms for less than 1 year In 9 sarcoma cases, there were 6 patients who came to operation within 6 months after first noticing the tumor, the 3 others coming after 2, 16 and 30 years, respectively It seems evident, therefore, that patients with malignant disease come to the hospital much sooner for advice than do

TABLE I—AGE OF ONSET BY DECADES

	Mixed tumors	Carcinoma	Sarcoma	Unknown pathology	Total in each age group
1-10	1	0	0	0	1
11-20	5	0	1	13	19
21-30	9	3	0	23	35
31-40	13	2	4	17	36
41-50	4	11	2	12	29
51-60	3	6	3	14	26
61-70	1	5	1	4	11
71-80	0	2	0	2	4
Total no. of cases	36	29	11	87	163

TABLE II—SEX

	Males	Females
Unknown pathology	71	52
Mixed tumors	18	22
Carcinoma	15	15
Sarcoma	6	4
Total	110	93

TABLE III—SIDE INVOLVED

	Right	Left
Unknown pathology	46	37
Mixed tumors	20	18
Carcinoma	12	18
Sarcoma	5	5
Total	83	78

those with benign tumors The greater rapidity of growth of malignant tumors, often observed by the patients themselves, may thus be an important factor in the diagnosis

*Pain* Of 39 patients with mixed tumors 32 had no pain Of the 7 remaining, only 1 had really severe pain, 1 had steady dull pain at night, and 2 complained of pain on movement of the jaw In patients with malignant tumors, on the other hand, pain was much more common, being present in 16 out of 30 cases, and variously described as "cramp-like," "very severe," "unbearable for past 2 weeks," "neuralgic," and sometimes radiating to the head, face, neck, jaw, eye, and back of the ear The 11 cases with malignant growth treated at the Huntington Hospital are not included in the 30 mentioned cases as they are in a little different group, having often been seen in advanced stages of the disease when pain would naturally be expected, and being suitable cases only for X-ray or radium treatment In 3 of these latter cases, there is no note as to pain, 2 had no pain at all, 2 had occasional or very little pain, and 4 had very severe pain, particularly in the late stages Pain is thus

very common in patients with malignant tumors, both early and late in the disease, but relatively rare in patients with benign tumors. Pain is probably due to pressure on the fifth nerve, and is, therefore, to be more commonly expected in large tumors.

**Size** The largest tumor in this series was "twice the size of a fist", it was a sarcoma, of 30 years' duration, in a man 72 years old (Case 66, Fig 1). He was operated upon in 1889, the common carotid artery ligated, and an extensive operation performed, resulting in his death 3 days later from shock and paralysis. The largest parotid tumor on record, according to McFarland, was one reported by Conterill.<sup>1</sup> McFarland says "It was more than twice the size of the patient's head, and is said to have weighed 26 pounds. It was not operated upon." The most common size seems to be that of an English walnut, the smallest tumor described being the size of a peanut. Several *mixed tumors* of 10 to 20 years' duration are described as walnut-sized, while a number of *malignant* tumors of only a few months' duration are already as big as a small apple. The greater rapidity of growth of malignant tumors is thus strikingly shown.

**Consistency** Practically all parotid tumors are described in the records as hard. Consistency, therefore, gives us very little aid in the clinical diagnosis between benign and malignant tumors. A few mixed tumors may be of the "consistency of a lipoma," "tensely fluctuant," or "partly fluctuant." We feel that there are probably different degrees of hardness, and that, with enough experience, the stony hardness of malignancy may be helpful in the diagnosis, and that a definitely soft tumor is likely to be benign.

#### TREATMENT

The treatment in practically all cases should be operative. Radium or X-ray treatment in our experience has been only palliative, never curative. Moreover, without operation, no pathological report is obtained, so that, not knowing with what type of tumor we are dealing, the treatment may be unsatisfactory, and no conclusions can be

drawn from it. In a very large malignant tumor, in which there is no hope of cure, radium or X-ray may be used, but is chiefly valuable in recurrent malignant tumors. We are aware that some surgeons may have a higher regard for radiation treatment than we have, but certainly in this relatively large series of carefully followed cases, there is no evidence for attributing the permanent cure of a single parotid tumor to the use of X-ray or radium.

#### OPERATIVE TREATMENT

The ideal procedure is to have a competent pathologist at one's elbow ready to advise and to make a frozen section diagnosis on a small piece of tumor tissue removed for biopsy. Then, if the report is a benign tumor, the facial nerve will not be needlessly sacrificed, but if the report is malignant, it should be sacrificed if necessary without a moment's hesitation, and a very extensive removal of the entire parotid gland, together with a complete neck dissection, should be done. All too often, we believe, has an incomplete operation been performed, saving the facial nerve, but not curing the disease. Sometimes it may be necessary merely to do a biopsy at the first operation, waiting a few days for a fixed section report before continuing with the operation. This procedure, while it subjects the patient to two operations, enables careful study by the pathologist of a stained specimen and will be more satisfactory than a doubtful frozen section diagnosis.

At the time of operation the question of *encapsulation* may be of importance and should be noted by the surgeon. Encapsulated tumors are more likely to be benign, but care should be exercised not to rupture the capsule in removal, as spilling of the contents may be the source of a recurrence, which may be malignant, though probably more often the recurrence will be mixed tumor, if the original growth was mixed tumor. We have only one case in our series which started as a mixed tumor and later recurred as a carcinoma (Case 42), in this case definite mention was made by the surgeon at the first operation of the capsule



experience we have seen a number of parotid tumors which were apparently unaffected by radium treatment." As previously mentioned, the difficulty in evaluating the results of radiation treatment is chiefly because of the lack of a pathological report. Twenty-three such cases were treated at the Huntington Memorial Hospital with X ray or radium or both. A number of these cases had also had an excision of the tumor performed elsewhere, but no satisfactory pathological report had been obtained. Low and high voltage X ray were each used at times, but radium was felt to be more effective, and was, therefore, used in practically all the cases. The usual X-ray dosage was 200 r units to each side of the face and neck, repeated about every 2 months. Radium was given in the form of steel radon tubes, usually at a distance of 2.5 centimeters from the tumor, and screened with 0.5 millimeter of lead, glass or gold seeds were also used in almost all cases. The total dosage at any one treatment averaged between 2,000 and 2,500 millicurie hours. Treatments were generally given at monthly intervals, some patients receiving only a few, but many receiving up to twenty or more treatments with and without X ray.

The results of radium treatment in these 23 patients are summarized in Table IV.

TABLE IV — RESULTS OF RADIUM

	Cases
Died	8
Living—nodules still present	5
Had excision as well as radiation	16
Apparently cured (diagnosis doubtful)	2

Many of the same patients have been counted more than once in this summary.

Of the patients who died, there is little to be said, except that most of them died within 6 months after radiation treatment was begun and all died within 2 years. They undoubtedly had malignant tumors, although pathological proof is lacking in all of these cases.

In regard to the second group, it might be said that the nodules remaining after treatment are merely scar tissue, but some of them seemed to be growing larger when last seen. Only further excision and microscopic examination would answer this question.

Concerning the third group, we feel that no conclusions can be drawn regarding the benefit from radiation. In a number of these cases, radium or X ray was merely used as a prophylactic postoperative measure, and the credit for a good result must go chiefly to the surgeon, as most benign parotid tumors are cured by surgery alone.

On further examination of the records there is also considerable doubt about the fourth group, which comprises only two cases, for in the first of these there had been a radical neck operation at another hospital, 6 years prior to the radium treatment for supposed mixed tumor of the parotid, making it possible that the parotid lesion was a part of the original process in the neck, whatever that may have been, and in the second case, the tumor of the parotid, which was felt clinically to be more inflammatory than mixed tumor, was getting rapidly smaller for 2 months before radium treatment was instituted. Evidence that radium and X ray treatment are useful palliative procedures is contained in many of the records, but proof that radiation therapy has cured any parotid tumor in this series is lacking.

#### PROGNOSIS—MIXED TUMORS

In the mixed tumor group the prognosis as to life is good, although recurrence takes place several times in many instances. Of 40 mixed tumor cases, in only one patient did a mixed tumor later become malignant. This case has been referred to already. The 39 other patients have all lived at least 5 years after the last operation, with the exception of 4 cases followed only 2, 3, 4, and 4½ years, respectively.

**Recurrence.** Mixed tumors, do, however, recur not at all infrequently, but the recurrence is almost always benign. Two patients have had a recurrence but have refused further operation.

**CASE 11** A boy of 16 years entered the Massachusetts General Hospital in January, 1919, having had a tumor in the right parotid region for 7 years. This had been excised once in 1915 by his own doctor. Operation was performed and the tumor was removed. The pathological report was mixed tumor. Recurrence took place 2½ years later and was treated eight times with radium at the Hunt-

ington Memorial Hospital, beginning in 1922. Treatments were given at intervals of 4 to 6 weeks, the dosage varying from 1,206 millicurie hours to 3,530 millicurie hours, the usual dose being about 2,000 millicurie hours. Steel radon tubes were used each time, usually about four of them, at a distance of 2.5 centimeters from the lesion, and screened with 2 millimeters of lead. Careful notes were kept at each treatment, and little or no change in the lesion was observed at any time. In 1926 a letter was received from the patient stating that the size of the tumor was just the same. In 1927 a partial removal of the tumor was done by a surgeon in New Hampshire. In 1928, when he was again seen at the Huntington Memorial Hospital, eight shotty nodules were still present.

The other case (Case 27) gives a similar history of operation at the Massachusetts General Hospital in 1914, the microscopic examination showing a mixed tumor. Eight radium treatments were subsequently given at the Huntington Memorial Hospital in 1922, the dosage and manner of treatment having been similar in every way to that given in the first case. Just before the seventh treatment it was noted that there was certainly no decrease in the size of the tumor, and a month later there was thought to be possibly a slight extension of the growth. This patient was seen by us in 1928, 5 years after her last radium treatment, at which time she had a firm, hard mass in the right parotid region the size of an English walnut. Operation was advised, but refused.

We thus have evidence, in these 2 cases at least, of the ineffectiveness of radium in proved mixed tumors.

Of 40 cases, 36 lived over 5 years after the last operation, 21 over 10 years, 6 over 20 years, and 3 over 30 years. The follow-up statistics could not cover any longer periods of time in these cases because of the deaths of 12 patients from other causes, and because of the comparative recency of many of the operations.

Twelve patients in the 40 mixed tumor cases, or 30 per cent, had one or more recurrences. Five of the 40, or 12.5 per cent, had two recurrences. There were thus 17 recurrences in 40 cases, or 42.5 per cent. Of all these recurrences, however, only one was malignant. Judging from our series, therefore, there is one chance in 40 (2.5 per cent) of a mixed tumor recurring as a malignant tumor, and one chance in twelve (8.3 per cent) of a recurrent parotid tumor, previously reported microscopically as mixed, proving to be malignant.

The length of time recurrence was noted after operation is not recorded in all cases, but varies from immediate recurrence to 5 years after operation. The number of years elapsing between operations was never less than 2, and was often 5 or 10, being 16 in 1 case and 20 in another. In 5 cases in which recurrence took place, it was noted at the time of operation that the tumor was not completely removed. In 4 cases in which the tumor recurred immediately, it grew so slowly and caused so little discomfort that further operation was postponed by the patient for 9, 10, 13, and 20 years, respectively.

Ewing discusses the clinical course of mixed tumors as follows: "In the great majority of cases a quiescent tumor has long preceded the development of an active growth. Very often the quiescent nodule was observed for 8 to 10 years, Paillet reporting an inactive period of 37 years, and Wood 53 years. Trauma rarely appears as a possible factor. Once established, active growth proceeds slowly, but varies with the histological type.

Surgical removal is often followed by recurrences of increasing malignancy. On the other hand some old tumors, becoming active, soon infiltrate the capsule and gland, and even invade the lymph nodes in a few months. After surgical interference encapsulated growths do not, as a rule, recur, but others are very prone to return at once or after an average interval of 2½ years, or as late as 9 years. In Wood's 37 cases, there is a record of 17 recurrences (45 per cent) while 12 cases were checked by a secondary operation, and 20 (55 per cent) were permanently cured. Successive recurrences with many operations have extended over a period of 20 years (Wood) and 23 years (Billroth). In the recurrent tumors the structure may remain constant, but more often it becomes increasingly cellular, atypical, and malignant." Our percentage of recurrences (42.5 per cent) agrees very closely with Wood's (45 per cent). We have also records of successive recurrences extending over more than 20 years, and have a record of 1 patient, who had three operations and is now living 51 years after she first noticed the presence of the tumor.

## PATHOLOGICALLY MIXED TUMORS—MASSA

Date	Identification	Age on admission	Age at onset	Sex	Duration	Right or left	Pain	Size	Consistency
5-7-10	24 E S 10753	30	32	F	7 yr	R	None	?	Tensely fluctuant
5-2-11	25 E S 102763	24	3	M	7 mo	R	Yes for past 2 mo an lower portion	English walnut	Placid
5-6-13	26 F S 121253	35	31	F	2 yr	L	Yes steady dull pain all night	4 1/2 cm	Hard
4-10-14	27 E S 191331	28	24	F	4 yr	L	None	?	Soft fluctuant
5-10-10	28 W S 105903	41	?	M	?	?	?	English walnut	?
5-18-15	29 S 222609	28	24	F	4 yr	R	None	2 1/2 x 2 1/2 cm.	Hard
11-12-15	30 F S 105749	30	20	M	8 mo	L	None	1 1/2 walnut	Hard
8-24-15	31 W S 110131	35	30	M	2 yr	R	None	Hen's egg	Hard
12-20-13	32 W S 10797	47	15	M	2 yr	R	Slight, occasional	10 x 15 cm.	Hard
6-6-07	33 S S 10107 p 35	30	20	M	(12) 10 yr (13) 4 yr recurred immediately a day (13) 4 yr	R	?	Cranberries	?
6-3-03	34 E S 11392	30	?	F	?	L	None	English walnut	?
1-10-06	35 S S 1014 p 307	16	10	F	2 yr	R	None	Peanut	Hard
4-1-07	36 E S 10170 p 745	30	15	F	15 yr all 6 yr present	R	Never	1 Walnut 2 ? 3 Pin	Semi-fluctuant
4-14-09	37 W S 102779	26	23	F	5 yr	L	None	2 oranges	Firm
12-6-02	38 W S 11 p 201	27	23	F	4 yr	R	None	Hen's egg	Hard
7-5-06	39 S S 130212	34	33	M	10 yr	R	None	2 Distal phalanx of thumb 3 Quarter	1 Hard 2 Hard
6-16-03	40 W S 137717	30	34	M	2 yr	L	Yes for past week on opening mouth too wide	2 1/2 cm	Hard

## CHUSETTS GENERAL HOSPITAL CASES—Continued

Operation	Encapsulated or not capsule broken	Vessels ligated and damage caused	Nerves damaged	Length of life after last operation	Length of life after first noticed	Recurrent	Radium or X-ray treatment	Remarks Cause of death as on death certificate
Excision	Yes shelled out			18 yr	25 yr	None		
Excision	Yes enucleated		Facial cut and sutured to the No damage	14 yr	14 1/2 yr	None		Very temporary damage from cutting facial
1 Incision and drainage 6 mo ago 2 Incision and drainage 3 wk ago 3 Excision	Yes capsule ruptured			20 yr	1 yr	None		
Curetted				13 yr	17 yr	Lump size Eng. 1 1/2 h walnut	Yes—May 1922 Hunt ington 8 Gam ma	Patient seen swelling never went away altogether after operation in 1914 Further operation advised but not done
1 Excision 2 Operation out side Sept 1924	1 Yes capsule broken with escape of broken down tissue			5 yr	10 yr	Yes but not since last operation 5 yr ago		
1 Local surgeon 3 yr ago 2 Excision				10 yr	14 yr	None		
Excision	Yes shelled out			14 yr	14 yr	None		
Excision	Yes easily removed			10 yr	12 yr	?		Died 20 yr Cerebral hemorrhage
Excision	Yes easily shelled out			16 yr	18 yr	?		
1 Excision 10 yr Local surgeon 2 Excision 4 yr Local surgeon 3 Excision Mass Gen Hosp	3 Shelled out Broke with escape of cheesy material			27 yr	37 yr	3 operations ?		
Excision				25 yr	25 plus?	None		
Excision	Shelled out			33 yr	35 yr	?		
1 Excision 13 yr ago 2 Excision 13 yr ago 3 Excision curetted Mass Gen Hosp	1 Partly encapsulated Scooped out capsule not removed			36 yr	51 yr	?		
1 Excision Local surgeon 1887 2 Excision Mass Gen Hosp 1889 3 Excision Mass Gen Hosp 1907	2 Removed piece meal			12 yr	37 yr	3 operations ?		Died 12 yr after last operation Myocarditis Grave's disease
Excision	Yes adherent not shelled out			30 yr	34 yr	Yes but was not operated on again no pain		Died 30 yr Inter Apoplexy
1 Excision 1906 2 Excision 1916	1 Yes sac opened and caseous material escaped 2 Removed with difficulty in fragments			13 yr	33 yr	2 operations no record after second		
Excision	No	Common carotid No damage	Facial nerve	16 yr	28 yr	No	No	

## PATHOLOGICALLY A BENIGN CYST—MASSA

Date	Identification	Age on admission	Age at onset	Sex	Duration	Right or left	Pain	Size	Consistency
6-22-23	41 ES 256007	32	33	M	9 yr	R	None	1 Walnut small 2 Lemon	Cystic

## PATHOLOGICALLY MIXED

10-15-90	42 ES Vol 260 p 32	46	36	M	20 yr	R	1 None 2 Very little	1 Turkey 1 egg 2 Egg	1 Hard 2 Firm
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## PATHOLOGICALLY

7-25-21	43 SS 277105	40	38	M	2 yr	L	Yes cramp-like under left ear	2x2.5 cm	Hard
9-12-17	44 W S 217425	45	45	Bl	7 wk	L	None	Two lumps each about size of walnut	?
1-22-23	45 267002	52	41	Bl	22 yr	L	Pain 2 mo. Unbearable for past 2 wk	Large plum	Hard
2-23-09	46 S S 262457	28	27	Bl	7 mo	L	None	Pigeon 2 egg	?
6-22-16	47 ES 209083	72	72	M	6 mo	L	None	Walnut	Firm
8-2-23	48 S S 290494	57	55	F	22 yr	L	Yes at night	2.5x2.5x2.5 cm	Hard
1-25-93	49 S S 24 p 266	51	50	M	9 mo	R	Yes right eye and parotid region	1/2 apple	Firm
2-18-09	50 W S 17 343 p 75	52	50	Bl	2 yr	L	No	1 cm	Hard
5-29-00	51 SS 100122	62	62	Bl	2 mo	R	Yes right side of neck	6.5 cm diam	Hard
7-5-05	52 ES 143278	43	43	M	1 mo	R	None	4 cm diam	Firm hard
12-8-06	53 ES 150370	72	72	M	3 mo	R	Yes behind right jaw	?	?
6-10-11	54 W S 2435 S	67	67	F	10 wk	L	Yes new algic pain for 3 wk over left side of face	Small apple	Hard
8-20-01	55 SS. Vol 47 p 216	60	59	F	6 mo	R	Yes radiates to ear and under jaw	2x3 inches	Hard
1-29-03	56 254334	56	56	F	3 mo	L	None	2x3x2 cm	Hard
5-28-09	57 W S 264154 W S 266602	33	32	F	2 yr	R	Yes chiefly to neck	4x2 cm	Hard elastic

## CHUSETTS GENERAL HOSPITAL CASES—Continued

Operation	Encapsulated or not capsule broken	Vessels ligated and damage caused	Nerves damaged	Length of life after last operation	Length of life after first noticed	Recurrence	Radium or X-ray treatment	Remarks Cause of death as on death certificate
1 Incision 1919 2 Excision 1923	Cystic			5 yr	14 yr	None after last operation		

## TUMOR, LATER CARCINOMA

1 Excision mixed tumor 2 Excision cancer	First operation encapsulated Capsule broke and mushy contents squeezed out			14 yr after first operation 1 yr after second operation	24 yr	Yes	?	Cancer Glands of neck General sepsis Pressure on larynx
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## CARCINOMA

Partial excision	No note	Jugular vein External carotid No damage	Partial no note of damage	3 mo	15 mo	Not stated	No	Angio sarcoma neck
Excision	No note	None	None	6 mo	8 mo	Not stated	No	General carcinoma tosis
Partial excision and implantation of radium done twice	No note	None	None	5 mo after first operation 2 mo after second operation	11 1/2 yr	Yes	Radium	Recurrence
Excision	No note	None	Facial and spinal access No note after operation	6 mo	13 mo	Yes	No	Recurrence Venous thrombosis
Excision	No note	None	None	6 mo	1 yr	Not stated	No	Carcinoma of neck
Excision	No note	Common carotid right cerebral monoplegia Paralysis right arm	Facial	5 mo	22 yr 3 mo	Yes	No	Cancer
Excision curetted Cautery	No	Common carotid No note of any damage	None	14 mo	23 mo	Yes	No	Cancer of jaw and liver
Excision	No	None	None	1 yr	3 yr	Yes	No	Cancer
Excision	Not stated	None	None	1 yr	14 mo	Yes	No	Hæmorrhage from cancer
Excision	No	None	None	16 mo	17 mo	Yes	No	Cancer of neck
Curetted	Not stated	None	None	11 mo	14 mo	Yes	No	Cancer
Excision	Not stated	None	None	7 mo	9 mo	Yes	Yes	Sarcoma of neck and mediastinum
Excision	No	None	None	1 yr	1 1/2 yr	Yes	No	Epithelioma of face
Excision	No	Jugular vein External carotid No damage	Complete left facial	2 yr	2 yr 3 mo	None locally	No	Carcinoma left parotid. Carcinoma lung Cerebral hæmorrhage
Excision cauterization neck dissection 23 operations in all	Yes—first time it was encapsulated Capsule not broken	None	None	15 yr after first operation 15 mo after last operation	16 yr	Yes repeatedly	Yes	Cancer of lung

## PATHOLOGICALLY CARCINOMA—MASSA

Date	Identification	Age on admission	Age at onset	Sex	Duration	Right or left	Pain	Size	Consistency
11-10-98	58 ES Vol 344 p 33	48	47	M	6 mo	R	No	Walnut	?
7-22-18	59 W S 223812	62	55	M	7 yr	L	None	Large walnut	Hard
5-6-10	60 W S 160 40	61	41	F	20 yr	R	No	Half orange	Hard
10-9-15	61 27457	59	38	F	1 yr	L	Occasional slight ache	5x3 1/2 cm	?
8-14 19	62 W S 232182	60	44	F	22 yr	L	Very painful	?	Hard

## PATHOLOGICALLY

11-15-17	63 S 218667	37	36	M	6 mo	R	None	Almond	Hard
1-20-00	64 SS Vol 40 p 253	32	31	M	6 mo	R	Yes, severe rt neck an behind ear	1.5x1.0 cm	Hard
12-1-18	65 W S 226770	44	44	F	4 mo	R	None	5/8 cm diam	Hard
7-2-89	66 F S Vol 124 p 110	72	42	M	10 yr	L	Yes—up left side of head lately	Twice size of fist	Hard
8-30-0	67 W S 138905	55	53	F	5 wk	L	Yes—left parotid cheek— shoots to eye	History not	Hard
3-3-93	68 W S 209 p 62	62	62	M	5 mo	L	None	Hen's egg	?
11-3-09	69 SS 167552	38	58	M	?	L	None	?	?
4-29-23	70 ES 240435	33	33	F	2 yr	R	None	1 1/2 in diam	Stringy soft, vascu- lar
3-22-15	71 W S 200807	49	49	F	4 yr	R	Only at onset severe	Walnut	Hard

## CHUSETTS GENERAL HOSPITAL CASES—Continued

Operation	Encapsulated or not capsule broken	Vessels heated and damage caused	Nerves damaged	Length of life after last operation	Length of life after first noticed	Recurrence	Radium or X ray treatment	Remarks Cause of death as on death certificate
Excision	Not stated	None	None	2 yr	2½ yr	Yes	No	Cancer of face
Excision and cauterization 3 operations	No	None	Facial cut	9 yr after first operation 2½ yr after last operation	9½ yr	Yes	Yes at radium treatments	Endothelioma parotid gland
Excision	Not stated	None	None	22 mo	22 yr	Yes	No	Sarcoma of spine
Excision	Lower part encapsulated Upper part infiltrating		Lower facial	3 yr	4 yr	No	No	Living now
1 Albania 1915 2 1919 3 1924 4 1925 Excision every time	No		Facial complete	11 yr after first operation 1 yr after last operation	23 yr	Yes	Yes 30-40 X ray treatments without improvement	Gall stones in 1926

## SARCOMA

1 Excision 2 Excision of node	1 Encapsulated and broken			3 yr after first operation 3 mo after last operation	3½ yr	Yes	No	Recurrent sarcoma parotid and neck
Excision and neck dissection		Jugular vein External carotid No damage		10 days	6 mo		No	Hæmorrhage
Excision		Common carotid Anæmia with œdema and softening right cerebral hemisphere		8 days	4 mo		No	Hæmorrhage
Excision		Common carotid shock paralysis right arm and leg		3 days	30 yr		No	Shock paralysis
Excision and curettage	No	External carotid no damage	Facial	3 mo	4 mo	Yes	No	Sarcoma of parotid cerebral embolus
Portion curetted	No			1 yr	1½ yr	Yes	No	Sarcoma of neck
Excision		Jugular vein no damage		5 yr after last operation	?	Yes	Yes	Sarcoma of parotid
Excision	No		Facial no paralysis	7 yr	9 yr	No	No	Now living
Excision	Yes fairly adherent			9 yr	9 yr	?	?	Pulmonary infarct Chronic mitral disease



## PATHOLOGICALLY CARCINOMA—HUNTING

Date	Identification	Age on admission	Age at onset	Sex	Duration	Right or left	Pain	Size	Consistency
10-19-13	72 12315172	34	30	F	4 yr	R	Yes very severe at end	4x5 cm	Hard
3-15-14	73 24351	31	28	M	30 yr	L	Yes very severe at end	6x10 cm	
4-27-23	74 23469	65	55	F	Mumps 55 yr a with tender glands ever since no yr growing bigger	I	Very little	4 cm diam	Hard
5-12-17	75 127106	?	7	F	23 yr	R	?	?	Hard
11-21-20	76 207307	50	47	F	3 yr	L	Occasional	3x3 cm	?
4-8-21	77 22746	46	45	M	6 mo	I	No pain & difficulty in swallowing		Hard
11-17-21	78 221437	46	45	F	8 mo	L	Yes much at end	5 cm diam	Hard
7-7-22	79 22349	67	64	F	3 yr	R	No	?	?
5-3-25	80 25140	67	66	F	1 yr	R	Yes severe Recurrent cancer parotid with lung metastasis cerebral hemorrhage last operative shock lung abscess	Lemon	

Our own feeling is that the prognosis in mixed tumors is rather more favorable than Ewing would lead us to believe. Our cases seem to bear out the ideas of Wood, who says "While these tumors may grow slowly and even remain innocuous for 20 or 30 years, they occasionally undergo changes which are evidenced by a sudden increase in growth rate and rapid involvement of the surrounding tissue, with metastasis to regional nodes. Under these circumstances squamous cell epithelioma and spindle cell sarcoma have been found superimposed on a mixed tumor. Such alteration in type is fortunately rare."

**Metastasis.** Mixed tumors in this series recurred locally, but never produced distant metastases.

McFarland's (7) conclusions are substantiated by our findings. Among his conclusions are the following

"They (mixed tumors) are inherently benign, but commonly recur after excision, and if frequently disturbed become locally destructive and invasive, without giving metastasis."

'Malignant change, whether 'sarcomatous' or 'carcinomatous,' in mixed tumors must be rare and its occurrence is difficult to prove."

"As intervals of 10, 20, and even 30 years may elapse between the operative removal of a mixed tumor and its recurrence, caution should be exercised in declaring any case to be cured."

## PROGNOSIS—CARCINOMA

In carcinoma of the parotid gland the prognosis is very bad. Very few patients have been cured, but we believe that extensive operation is the only hope and may result in some cures. Of 30 cases of proved carcinoma treated by

## TON MEMORIAL HOSPITAL CASES

Operation	Encapsulated or not capsule broken	Vessels ligated and damage caused	Nerves damaged	Length of life after last operation	Length of life after first noticed	Recurrence	Radium or X-ray treatment	Remarks Cause of death as on death certificate
Excision 1915 Local surgeon	3		Right facial paralysis	1 yr	5 yr	Yes	16 radium treatments	Cancer of parotid and neck
Excision 1923 Local surgeon				1 yr	31 yr	Yes	Yes both	Cancer parotid neck and question brain
Biopsy				No operation	58 yr	Yes	Yes 18 radium treatments	Cancer parotid
Local surgeon Worcester			Right facial paralysis	3 yr	5 1/2 yr	Yes	No	Cancer of face and neck
Biopsy of gland				Only biopsy 3 yr	6 yr	Yes	13 radium treatments	Cancer neck hypostatic pneumonia
Excision 1912 Boston City Hospital			Partial left facial	1 yr	1 1/2 yr	Yes	gradual and X-ray treatments	Cancer parotid and neck paralysis of palate tongue and vocal cord
Excision, 1922 Local surgeon				1 yr	1 1/2 yr	Yes	X-ray treatments	Cancer parotid
Excision 1919 Local surgeon			Lower facial	1 mo	11 yr	Yes	5 radium treatments X-ray series improved facial paralysis	Living Pathological report 1920 slow growing adenocarcinoma—? coil gland origin not characteristic of parotid
Excision 1922 Local surgeon								
Excision 1929 Huntington								
Excision 1914 Local surgeon				3 yr	4 yr	Yes	X-ray treatment	Recurrent cancer parotid with lung metastasis Cerebral hemorrhage Postoperative shock lung abscess

operation (with or without radium) at the Massachusetts General and Huntington Memorial Hospitals, there is only 1 now living and apparently free of the disease, an ultimate mortality of 90.7 per cent. All the other cases died of cancer with the exception of 2, 1 of whom (Case 62) had four operations, three of them for recurrences, thirty X-ray treatments (with very little if any benefit), but who finally succumbed to gall stones, at the age of 73 years, 1 year after her last parotid operation. The other patient (Case 79) still living now, was a woman of 67 years, who had had the tumor excised by her own doctor in 1919 and again in 1922, followed by a series of X-ray treatments in 1923, and five radium treatments in 1926, after which the tumor practically disappeared. In December, 1929, however, there was a recurrent nodule, 2 centimeters in diameter, which was excised, and reported

to be slow growing adenocarcinoma, question of sebaceous gland origin, not characteristic of parotid. Obviously neither of these patients can be considered cured, as the first one still had the tumor at the time of her death from gall stones, and the other patient has had a recent recurrence. Moreover, the recent pathological report in this latter case casts some doubt on the origin of the tumor. Our one "cured" case (Case 61) is only a 3 year cure, as her operation here was quite recent (1925) and we have been unable to get in touch with her since 1928. Presumably the growth was not very malignant, as the surgeon described it as "encapsulated in its lower portion" but "apparently infiltrating in the upper part." The pathological report, however, was adenocarcinoma.

*Local recurrence* after removal of parotid cancer is usually very prompt, being a matter

of months rather than years. Secondary operations have been uncommon, only 5 patients having been operated on more than once. One patient (Case 57, Figs 2 and 3), however, was operated on twelve times between 1909 and 1922, the pathological report every time being carcinoma, and the various operations including excision, cauterization, neck dissection, radium implantation, etc. The last operation was a biopsy of the lung, which proved to be metastatic carcinoma. This patient died of recurrent carcinoma of the parotid with metastases to the lung in 1924.

*Metastasis* from cancer of the parotid may occur in the lungs, and one case of metastasis in the bones has been reported. We had 2 cases in which lung metastasis occurred, one (Case 56), a woman of 56 years, who had no local recurrence but who died, only 2 years after her operation, of cancer of the lung and cerebral hemorrhage, the other already mentioned (Case 57), a woman of 33 years, who had twelve operations, and who died 15 years after her first operation, of cancer of the lung. Another case, with metastatic nodules in the skin of the chest wall, has recently come to our attention.

*The length of life after operation* has been almost invariably short. Of 14 cancer patients not given radium or X ray treatment, none lived over 2 years after operation. Six lived between 1 and 2 years. Five died in 6 months or less. Of 10 cancer cases which did receive radium or X ray treatment in addition to excision, 3 lived over 2 years (2½, 3, and 5 years, respectively). Only one (Case 45) died within 6 months. The patient (Case 57), who was operated upon 12 times, and who also received radium and X ray treatment, lived 15 years after her first operation for cancer of the parotid. Radium thus seems to be helpful in prolonging life but not in curing the disease.

#### PROGNOSIS—SARCOMA

Here again in sarcoma the prognosis is bad, though apparently not as bad as in carcinoma. Of 9 patients, 3 lived over 5 years (5, 8, and 9 years, respectively). The patient (Case 69) who lived 5 years had three operations and radium treatments, and

died of sarcoma of the parotid. The patient (Case 70) living 8 years is now living, is free of any recurrence, and was seen very recently. She has never had X ray or radium treatment. The patient (Case 71, the melanotic sarcoma case previously mentioned) who lived 9 years, died of chronic cardiac disease and pulmonary infarct. She probably had no recurrence and no X ray or radium treatment, though this is not certain.

*Recurrence*. Three patients died only a few days after operation of shock or hemorrhage. (Two of these had had ligation of the common carotid artery.) Of the 6 remaining sarcoma cases, 4 had recurrence, 2 dying of sarcoma in 3 months, the 2 others in 1 year and 5 years, respectively.

*Metastasis*. There is no record in this series of any distant metastasis from sarcoma of the parotid. These tumors do, however, rapidly infiltrate neighboring structures, the lymphosarcomata metastasizing by the lymphatics and the fibrosarcomata probably by the blood stream.

#### TUMORS SECONDARILY INVOLVING THE PAROTID GLAND

In the study of this series of cases 7 more came to our notice as invading the parotid gland secondarily. Of these, 4 were carcinoma, 1 melanotic sarcoma, 1 malignant lymphoma, and 1 malignant tumor of uncertain origin.

The site of the original tumor in the carcinoma cases was different in each case, one originated in the neck, one in the cheek, one in the jaw, and another in the external ear, all resulted fatally in 1 day, 3 years, 8 years, and 17 months, respectively. The patient who died one day after operation had had a Crile clamp placed temporarily on the common carotid artery, and died of shock, never regaining consciousness. The 3 others all died of carcinoma.

The melanotic sarcoma case was as follows:

A man of 59 years entered the Massachusetts General Hospital in July, 1919 with a hard mass of 4 years' duration, about the size of a walnut, located at the angle of the jaw on the right side. Under either an encapsulated tumor of the parotid was



Fig 1 Case 66 Patient aged 72 years had had disease for 30 years Pathological diagnosis sarcoma of the parotid gland

excised The pathological report by Dr H F Hartwell was melanotic sarcoma of the parotid

This case, therefore, appears to be one of the very rare cases of melanotic sarcoma arising from the parotid gland, although it may have originated in the neck Unfortunately, we have been unable to trace this patient

The patient with malignant lymphoma first had symptoms in 1908, a chain of glands appearing in the neck Biopsy was done in 1912 Excision and neck dissection was done twice in 1913 A neck dissection, excision of the mastoid and the parotid gland, was done in 1915, and the parotid gland was again excised in 1916 In 1921 the death of this patient is recorded at the State House in Boston, the cause of death being 'sarcoma of the neck'

The malignant tumor of uncertain origin is the most interesting of all, for after repeated operations on a tumor that clinically seemed hopelessly incurable, and pathologically seemed extremely malignant, the patient, with the common carotid ligated, is



Fig 2, left Case 57 Patient aged 46 years, showing scars of face and neck after twelve operations for carcinoma of the parotid

Fig 3 Case 57 showing complete right facial paralysis

still living and well at the age of 72 years! The record is as follows

*First admission* E L, a man of 41 years, entered the Massachusetts General Hospital in March, 1898, with a history of having noticed a small pimple below the left ear, 14 months previously It had been cut off once with a horsehair, but had reappeared and enlarged Physical examination showed a series of large nodular masses on the left side of the neck An extensive operation was performed, the mass shelled out, and profuse hemorrhage resulted, necessitating ligation of the common carotid artery The pathological report was melanotic sarcoma

*Second admission* The tumor recurred immediately and the patient was readmitted in 2 months (May 30, 1898) Operation was again performed the "dissection carried down to the sternomastoid as thoroughly as possible, but with manifest little hope of eradicating the disease" The pathological report was again melanotic sarcoma

*Third admission* One year later the patient was again admitted, with a recurrence of about 3 months' duration Operation was done on May 24, 1899, and "the mass was dissected free down to the transverse processes of the vertebra beneath and cut off with scissors, some of the growth being left at the bottom of the wound" The pathological report this time was round cell sarcoma of the neck and adenocarcinoma of the parotid

*Fourth admission* In September, 1900, the patient was again admitted and the growth excised, but not removed, as the surgeon thought the tissue looked like normal parotid gland

*Fifth admission* In January, 1902, the patient re-entered the hospital with a tumor the size of a pullet's egg in the parotid region An external c

operation was performed a portion of the jugular vein, which was involved in the disease, being ligated and removed. The pathological report was large round cell sarcoma.

*Follow up* This patient was seen by us in April 1927 and was found to be in excellent health, with no evidence of recurrence. There was complete left facial paralysis. In September, 1929, we heard that this patient was still living 27 years after his last operation!

*Pathology* A review of the microscopic slides in this case has shown a tumor composed of cells which appeared to be extremely malignant, and, although no definite diagnosis could be made it was probably not melanotic.

The value of repeated and extensive operations in apparently hopeless malignant disease is well shown in this case.

#### SUMMARY AND CONCLUSIONS

We have reported on a large series of parotid tumors, with complete records as to pathology and end results in 80 cases. The conclusions to be drawn are as follows:

1 Benign tumors are more common than malignant tumors in the ratio of about four to three.

2 Carcinoma is about twice as common as sarcoma.

3 Cysts, melanotic sarcomata, and adenomata are extremely rare.

4 Mixed tumors are essentially benign, but recur locally with great frequency. They rarely become malignant.

5 Malignant parotid tumors are very difficult to cure. Once the diagnosis is established, we advise early radical operation, including ligation of the external carotid artery and severing of the facial nerve when ever necessary.

6 Patients with mixed tumors live in definitely. Patients with malignant disease rarely live over 2 years after operation.

7 Radium and X ray are useful in the treatment of malignant parotid tumors, but only as palliative procedures. In the treatment of benign parotid tumors, radiation therapy is of benefit in some cases, but we believe excision is the treatment of choice.

8 Carcinoma, sarcoma, and malignant lymphoma may invade the parotid gland secondarily. Such cases usually end fatally, but one brilliant cure reported here justifies

many extensive operations, and emphasizes the importance of not giving up in our struggle against malignant disease.

Since the completion of this paper another case has come to our attention, interesting because of the youth of the patient, the high malignancy of the tumor, the metastases in the chest wall, and the rapid, fatal termination.

A LeF (F S 288980) a boy of 15 years entered the Massachusetts General Hospital on February 1, 1928 complaining of a tumor on the right side of the face of 5 months duration. There had been no pain. Examination showed a "firm elastic smooth non tender egg sized swelling, lying over the right mandible and extending from the angle of the jaw forward to the submaxillary region. Above it extends on to the cheek and below it extends inward beneath the ramus of the mandible. It is quite freely movable in its superior part but is apparently fixed to the bone inferiorly and is more firm and indurated here than above. At its dependent portion there is a fresh scar about 2 centimeters long from a biopsy done 2 weeks ago." Operation was performed within a few days "the tumor tissue was resected entirely, regardless of structures." Convalescence after operation was good and the patient was discharged from the hospital in about 2 weeks, after completing a series of X ray treatments.

*Pathological report* showed "a tumor the size of a tennis ball aggressive and rapidly growing. An adjoining lymph node was negative for metastasis. Carcinoma."

*Follow up* The patient was followed during March and April in the tumor clinic. On April 6 five or six skin nodules were noted on the chest wall. A biopsy was done which showed metastatic carcinoma, and further X ray treatment was given and caused some of these nodules to disappear almost entirely. In spite of X ray treatment, however a rapid recurrence of the growth took place at the original site. Further metastatic nodules appeared on the chest wall, and the patient died on May 14, 1928 only 3 months after operation, and only 8 months after the tumor was first noticed.

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## INTRATHORACIC NEW GROWTHS

### RESULTS OF SURGICAL TREATMENT IN TWENTY-FOUR CASES<sup>1</sup>

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THE seeming increase in the incidence of intrathoracic tumors undoubtedly is due to the marked advancement that has been made in the methods of thoracic diagnosis and not to an increase in the occurrence of these new growths. The most significant advancement in early diagnosis has been made since the advent of the roentgen-ray. Recognition of these tumors before the patient is *in extremis* has led to the application of various types of treatment for relief of symptoms. Roentgen-ray and radium are the more commonly used agents in conservative treatment. In some of the malignant growths, such as sarcoma, malignant lymphoma, and endothelioma, there has been improvement or delay in the progress of the disease. In adenocarcinoma there has been little if any improvement. The lack of response to treatment of many of these tumors, and knowledge of the frequency of occurrence of benign tumors which do not respond to conservative treatment, and which may undergo malignant degeneration, has stimulated surgical intervention, with the purpose of removing the growth completely.

In 1929, I reported 17 cases of intrathoracic tumor in which the growth had been removed by transpleural operation in the previous 4 years. I am here giving complete reports of the 7 cases in which I have operated in the last year. In 5 of these cases the tumors were primary in the thorax and mediastinum, in 2 cases they were metastatic carcinomata and were of unusual interest from a diagnostic

standpoint because they could not be distinguished from primary thoracic tumors before operation. I am also giving a brief summary of the symptoms, methods of diagnosis, surgical treatment, and results to the present time of the entire series of twenty-four cases.

### SYMPTOMS

The symptoms and signs of intrathoracic growths depend on the size and situation of the tumor in the thorax. There are no characteristic symptoms by which early malignant lesions and early benign lesions can be distinguished. Pain is the most common symptom and usually is the chief complaint for which the patient seeks relief. The pain is usually more severe in malignant lesions than in benign lesions. This is particularly significant when the relative size of the tumors and their situation are considered. A benign tumor may fill from a fourth to practically the entire hemithorax without causing much pain or discomfort except on exertion, and most of the distress is caused then by dyspnoea from mechanical interference with breathing. A malignant tumor of much smaller size, in the same situation, will cause most excruciating pain, often most marked at night, or when pressure is exerted on the thorax.

Horner's syndrome was present in 3 cases in which a malignant tumor was found at the apex of the thoracic cavity. This, I believe, is due to infiltration and destruction with malignant cells of the inferior cervical ganglion, rather than to pressure from the size of



Fig. 1 Roentgenogram made on admission. There is marked density over entire left side of thorax to the level of first rib probably due to tumor with fluid. The heart is markedly displaced to the right. Case 1.

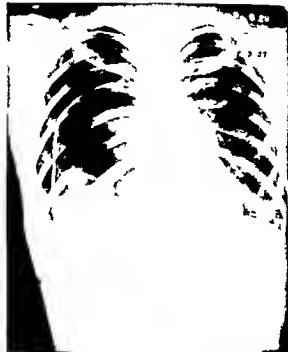


Fig. 2 Roentgenogram made after removal of 3,000 cubic centimeters of fluid and introduction of 2,250 cubic centimeters of air into the left pleural space. The shadow is of a large intrathoracic cystic tumor with fluid in lower fourth of the cyst. Irregular shadows indicate solid portion of the tumor. The left lung is completely collapsed. There is partial pneumothorax at the apex. Case 1.

the tumor, I have removed much larger benign tumors from the same site and Horner's syndrome was not present.

Most intrathoracic tumors are potentially malignant. Any tumor which has been dormant for a long time and which has begun to grow rapidly and to cause increase in pain, should be considered as probably malignant. This is particularly true of anterior mediastinal tumors of which teratoma or dermoids are the most common. These tumors usually cause more symptoms because of their confined situation and their structure. They contain a considerable number of glandular and secreting cells, and are usually cystic. The symptoms often simulate pleurisy because of the inflammatory reaction in the tumor which fuses it to the parietal and visceral pleura and all surrounding structures.

Dyspnea is more marked in cases of anterior mediastinal tumors than in tumors of the posterior or lateral portions of the thorax.

Cough is most marked in cases of tumor of the anterior mediastinum and in cases of

malignant tumor involving the lung. In cases of malignant tumor, it is usually of a dry, non-productive type or occasionally the sputum may be tinged with blood. In dermoid tumors there may be expectoration of hair, which is pathognomonic.

Vascular changes are not common and usually are seen only in lesions of the upper part of the thorax and of the anterior mediastinum.

#### METHODS OF DIAGNOSIS

The general examination is of greatest importance in determining the condition of the patient and always is the deciding factor in determining the type of treatment to be instituted. Examination of the thorax is of value in determining the situation of the tumor and the amount of impairment to respiration.

The roentgen ray is the most important single method of diagnosing the presence of an intrathoracic tumor and of distinguishing be-

tween a malignant and a benign lesion. The roentgenogram made from the anterior aspect is of value in determining the presence of an intrathoracic tumor and its vertical and lateral positions. Roentgenograms made from the lateral aspect determine the anteroposterior and vertical position of the tumor and its relation to the thoracic wall. Roentgenograms made obliquely are of value in determining the position of the tumor and its relation to the structures in the mediastinum, particularly the heart and aorta. Stereoscopic roentgenograms add visualization of depth to the determination of the lateral and vertical positions and give more accurate knowledge as to the relation of the tumor to the normal structures within the thorax. Roentgenographic studies of the relation of the tumor to the lung are greatly aided by preliminary artificial pneumothorax. This is of greatest value in distinguishing intrapulmonary and extrapulmonary lesions or whether the lung is adherent to an extrapulmonary lesion. If the lesion is intrapulmonary, the surrounding pulmonary tissue will collapse over the tumor. However, I have had 2 cases in which the tumor was in the anterior mediastinum, but the roentgenogram indicated that there was an intrinsic tumor of the lung. At operation the tumors were found to be extrinsic and the lung was so adherent that the pulmonary tissue collapsed over the growth.

Fluoroscopy examination is of great value in determining the site of the tumor and its relation to the normal structures within the thorax. It is particularly valuable in differentiating new-growths and expansile aneurisms of the aorta. In tumors of the upper mediastinum, it aids in differentiating primary intrathoracic tumors and substernal goiters, which elevate on swallowing.

Bronchoscopic examination is of great aid in differential diagnosis, particularly in ruling out primary intrabronchial disease, and malignancy. In some cases an extrinsic tumor may be indicated by narrowing of the bronchus.

Injection of the bronchial tree with iodized poppy seed oil, 40 per cent, may be of value in distinguishing between intrapulmonary and extrapulmonary lesions. Thoracoscopic examination may aid in selected cases in determin-



Fig. 3. Lateral view, made following removal of 3,000 cubic centimeters of fluid and introduction of 2,250 cubic centimeters of air into the left pleural space. The tumor occupies most of the left thoracic cavity and apparently originated anteriorly. The level of the intracystic fluid is increasing at the base of tumor, showing a saccular type of tumor. Case 1.

ing the type and position of the tumor but usually I prefer to do exploratory thoracotomy.

The chief problems associated with surgical removal of intrathoracic tumors are concerned with the danger of pulmonary collapse, with mediastinal flutter resulting from open pneumothorax, and the difficulty of access through the bony encasement of the thorax. The first of these hazards has been greatly diminished by the use of differential air pressure during the operation. The second is entirely a technical problem and the technique of methods of approach continually are being improved and perfected.

The surgical indications depend entirely on the observations in each case, and there is no type of surgery in which the ultimate result depends so much on the strictest attention to detail in each step of the treatment.

I believe that the operative risk is decreased by establishment of preliminary artificial pneumothorax for a few days before operation.



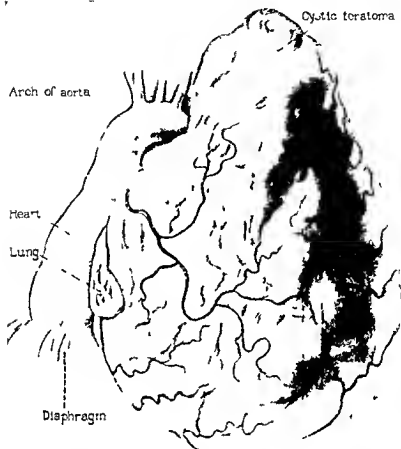


Fig 4. Appearance of the tumor at the time of operation. The anterior origin of the tumor with its attachment to the upper part of the pericardium and base of the great vessels and also the projection extending into the arch of the aorta, are represented. The large cystic mass completely filled the left half of the thorax, with complete collapse of the left lung posteriorly. Case 1.

to permit the patient to become accustomed to unilateral partial collapse and decreased vital capacity of the lung. In this series of 24 cases, preliminary artificial pneumothorax was established in 15 cases. During the pre operative period the patient should take at least 3,000 cubic centimeters of fluid daily.

I prefer to use intratracheal anæsthesia under positive pressure. I have operated with intrapharyngeal anæsthesia, with the closed mask, and without positive pressure of the anæsthetic, without harmful results. It is probable that intrapharyngeal anæsthesia would be satisfactory in most cases in which one pleural cavity is opened, but it is never possible to determine before operation what

emergency may arise or when the opposite pleural cavity may be opened unavoidably. I believe that anæsthesia by intratracheal insufflation, and administered with apparatus for positive pressure, is the safest method in most cases, this method was used in 17 cases of this series. The anæsthetic was ethylene and ether in practically all cases. Many of these operations are long and tedious and it is important to ventilate and re establish circulation by fully expanding the lung every 3 to 5 minutes during the operation. The amount of pressure used is gauged by a water manometer on the positive pressure apparatus. The lung is fully inflated at the completion of the operation. A suction pump is

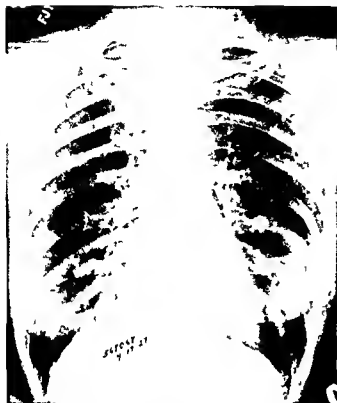


Fig 5 Roentgenogram taken on admission. The small, circumscribed shadow is in the right side of the posterior mediastinum, at the level of the fifth and sixth ribs, posteriorly. It was interpreted as probably indicating a benign tumor. Case 2.

applied to the intratracheal catheter, during its withdrawal, to remove any mucus which may have accumulated in the trachea.

The surgical approach through the thoracic bony cage depends on the site and size of the tumor. If the tumor is attached to any part of the bony thoracic wall, or if it is an outgrowth of the bony wall, laterally or anteriorly, I prefer to make the incision at the site of the tumor. In 8 cases of this series, anterior or lateral thoracotomy was done over the site of the tumor. If the tumor is in the anterior or posterior mediastinum, or in the lung, I prefer to do posterolateral thoracotomy, usually partially resecting a rib, and opening the pleura through the posterior periosteum. The vertical position of the incision, and the rib to be resected, depends on the site of the tumor. In 16 cases, posterior thoracotomy or mediastinotomy was performed to remove the tumor from the anterior or posterior mediastinum. In 18 cases, the tumor was removed in one stage, by a transpleural opera-



Fig 6 Photograph taken at the time of re-examination, 2½ months after operation. The wound is entirely healed. There is no deformity or limitation of function of the arm. Case 2.



Fig 7 Roentgenogram taken at re-examination, 2½ months after operation. The lungs appear normal. The evidence of partial resection of the fifth rib, and of a section of the fourth rib is seen. The right lung is fully expanded. Case 2.



Fig. 8. Roentgenogram of the thorax (lateral view) on admission. There is a large intrathoracic tumor filling the upper two thirds of right thoracic cavity and resting on the spinal column posteriorly. A large portion has protruded through the anterior thoracic wall with destruction of the second, third, and fourth ribs anteriorly. Case 3.

tion. This type of operation I believe, is the most satisfactory and should always be attempted if at all feasible. In one case the tumor was completely removed by extrapleural operation. This type of operation is rarely possible, because the pleura is so adherent to the tumor that the pleural cavity is ultimately opened more or less extensively before the tumor is entirely enucleated, with the associated danger of open pneumothorax. The greatest disadvantage of this procedure is the delay in healing, and the extensive pleural effusion which usually follows the operation. This is due to the trauma resulting from the extensive separation of the pleura from the thoracic wall. In one case the tumor was removed by a transpleural operation in two stages. The operation in two stages was planned because of the extensive procedure necessary. The first stage was done to separate the tumor from the surrounding structures and to form adhesions between the

TABLE I—CASES OF INTRATHORACIC TUMOR IN WHICH OPERATION WAS PERFORMED BETWEEN MARCH, 1925, AND MARCH, 1930

Operation*	Malignant		Benign	
Transpleural complete removal in one stage		7		11
Extrapleural complete removal in one stage				1
Transpleural complete removal in two stages		1		
Transpleural partial removal in one stage		4		
Deaths				
Operative mortality		1		1
Subsequent mortality		7		
Preliminary artificial pneumothorax was 1 in 15 cases				

TABLE II—CASES OF MALIGNANT INTRATHORACIC TUMOR IN WHICH OPERATION WAS PERFORMED BETWEEN MARCH, 1925, AND MARCH, 1930

Type of tumor, each one case	Extent of removal	Length of life following operation in months	
		Living	Dead
Osteofibrosarcoma graded 2	Complete	57	
Fibromyxosarcoma graded 1	Complete		27
Fibrosarcoma graded 1	Complete	6	
Fibro-osteochondrosarcoma graded 3	Complete		5
Sarcoma graded 3	Complete		4 5
Osteogenic sarcoma graded 3	Partial		1 5
Malignant endothelioma graded 4	Complete		25
Malignant endothelioma graded 4	Complete		2
Adenocarcinoma graded 3	Partial		3 5
Adenocarcinoma graded 1	Partial	1 5	
Adenocarcinoma graded 4	Partial	1	
Squamous cell epithelioma graded 4 (dermoid)	Complete		7 days*
Total number of cases		12	

\*Operative death, cerebral embolism.

visceral and parietal pleura above the tumor, walling off the remaining pleural cavity. The result of this procedure was unsatisfactory, inasmuch as an extensive pleural effusion formed and this delayed and increased the hazard of the second operation rather than decreased the risk as had been planned. I believe that, whenever possible, the operation should be done in one stage rather than in two stages. In 4 cases, in all of which there were extensive malignant conditions, the tumors were only partially removed at operation because of the inoperability of the condition. There were 2 operative deaths in the entire series of 24 operations, one on the second day and one on the seventh day (Table I).

The blood pressure is taken every 5 minutes during the operation. When there has been a fall of 10 millimeters of mercury in the pulse pressure, physiological solution of sodium chloride or glucose are given intravenously. If the pulse pressure drops 20 to 30 millimeters of mercury, a blood transfusion is given.

Postoperative care is very important. Maintenance of body heat is essential both on the operating table and after operation. The most significant immediate complication is dyspnea with cyanosis. If this occurs, the patient is placed immediately in the oxygen chamber. This often proves to be a life-saving procedure, for it tides the patient over the critical period of decreased vital capacity of the lungs. The oxygen chamber was used in 11 cases of this series. Later complications are pleural effusion and empyema. In practically all cases pleural effusion develops, but in about a third of the cases aspiration is not required. In about a third of the cases it will disappear after one aspiration, and in the remaining third it will require repeated aspirations. The frequency and persistence of the pleural effusion depend on the type of tumor and the amount of trauma to the pleura. In the cases with teratoma, pleural effusion is most likely to develop and may result in empyema. Empyema complicated the convalescence in 5 cases of this series, in all of which drainage was by the closed method. In one case subsequent open operation was required. All patients made a complete recovery.

Table II gives the type and grade of malignancy, the operative procedure and results to March 1, 1930, in all cases in which malignant disease was present. In 3 of the cases the clinical history indicated the presence of a tumor for many years, with recent increase in growth and symptoms. This suggested a primary benign tumor which had undergone malignant change. In the first of these cases, the tumor was a fibrosarcoma. The symptoms extended over a period of 24 years, for 21 years the symptoms had been mild and the condition had been treated as neuritis. At a time 3 years previous to admission to the clinic the pain had been of the same nature as before but had become progressively worse, morphine had been required for relief and



Fig. 9. Photograph taken on admission showing the large protrusion on the anterior thoracic wall. Case 3.

there were general symptoms of gradual loss of weight and strength. It is only reasonable to conclude that this tumor primarily was benign. This patient lived 27 months after transpleural removal of the tumor in one stage through an anterior incision in which the clavicle was cut. Death was due to recurrence. In the second case of the 3, the clinical history indicated the presence of a tumor for 6 years. At the patient's first visit to the clinic, 3 years before the time of which I am speaking, she had been advised to have an operation, but had declined. Two months previous to operation, the pain in the thorax became much more marked, was rapidly progressive, and radiated to the back. She had noticed loss of weight for 6 months. At the time of operation a fibromyxoid osteochondrosarcoma, graded 4, was removed. The patient died from recurrence 5 months after operation. It is possible that this was primarily a benign tumor which had undergone malignant change. This case (Case 4) is being reported more in detail in this paper. In the third case of the 3 a squamous cell epithelioma, which undoubtedly was a degenerated dermoid cyst, was



Fig 10 Roentgenogram taken at the time of the patient's first visit. There is a large circumscribed tumor in the upper part of the left posterior portion of the thorax and extending from the fourth to sixth ribs posteriorly. Case 4.

presented. Mild symptoms had been present for 4 years and had become severe in the 3 months previous to admission. The tumor was in the anterior mediastinum and was removed by transpleural mediastinotomy in one stage. Examination of the tumor disclosed the typical structure of a dermoid cyst, and the malignant tissue was situated in one region of the tumor which indicated malignant change in a benign tumor. This case was the only operative death in the malignant group, and the patient died, on the seventh day, of cerebral embolism.

In 8 cases the tumor was completely removed, 4 of the patients lived less than 6 months, and one patient is now living after 6 months. One patient lived 25 months, in this case it was necessary to resect the greater portion of the lower left part of the thoracic wall and a portion of the diaphragm, and to repair the defect with the remaining portion of the diaphragm after phrenicotomy. The tumor was an endothelioma of high grade and

was recurrent at the time of operation. The patient was relieved of symptoms for 22 months, when he began to fail rapidly and died from recurrence. One patient who had sarcoma lived 57 months after operation with no evidence of recurrence, and one patient lived 27 months after operation with relief of symptoms for more than 2 years and then died of recurrence. The results in these cases of malignant tumors do not seem to have any direct relationship to the type or degree of the malignant growth except in those cases in which adenocarcinoma of the lung is present, in these the prognosis is poor. The results in the other groups, although not satisfactory, are at least encouraging and emphasize the importance of operation before the disease has advanced beyond the possible limits of surgical removal or before malignant change has occurred.

In 4 cases the tumor was only partially removed because of inoperability due to extensive infiltration into the surrounding structures. In one case there was apparently a



Fig 11 Roentgenogram taken at the time of the patient's second visit 5 months after the roentgenogram shown in Figure 10 was made. No increase in the size of the tumor is seen. Case 4.

TABLE III—CASES OF BENIGN INTRATHORACIC TUMOR IN WHICH OPERATION WAS DONE BETWEEN MARCH, 1925 AND MARCH, 1930

	Length of life since operation months
Neurofibroma	41
Neurofibroma	24
Neurofibroma	11
Neurofibroma	5
Cellular fibroma	22
Cellular fibroma	22
Teratoma	17
Teratoma	16
Teratoma (dermoid)	13
Teratoma (dermoid)	7
Osteochondroma	24
Fibromyxochondroma*	
Total number of cases	12

\* Operative death died 2 days after operation from cardiac failure and shock.

sarcoma originating in the thoracic wall which had invaded the mediastinum. In the 3 others the tumors were adenocarcinomata, 2 were primary in the lung and 1 metastatic from a carcinoma of the thyroid gland. As would be expected, the operation had no influence on

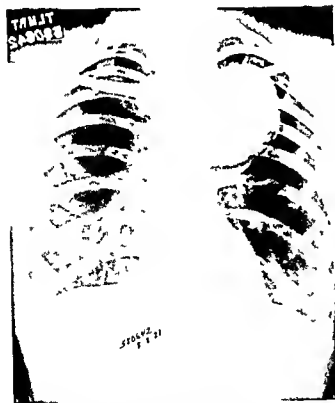


Fig 12 Roentgenogram taken 2 years and 5 months following the first visit. Marked increase in the size of the tumor has taken place. It is approximately a third larger than it was at the previous visit. The tumor extends from the third to the sixth interspace posteriorly. Case 4.

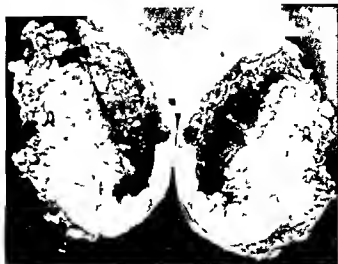


Fig 13 Photograph of the tumor, a hemorrhagic de generating fibromyxoid osteochondrosarcoma associated with a hemangioendothelioma weighing 220 grams. Case 4.

the course of the disease in this latter group. All of these patients were given treatment by roentgen-ray after operation, without benefit.

In Table III are given the types of tumors and results of operation in all cases of benign tumor.

In 12 cases of the entire series of 24 cases, the tumor was benign. In all of these cases the tumor was removed by operation in one stage. In 11 cases the operation was transpleural, and in 1 case it was extrapleural. There was 1 operative death on the second day, from cardiac failure and shock. This case will be reported in detail in this paper. Eleven patients are living from 5 to 41 months after operation, all have been completely relieved of symptoms and there has been little, if any, deformity or impairment of pulmonary function. Complete cure is to be expected in all of these 11 cases.

Four of these 12 cases were examples of neurofibroma in all of which the tumors were in the posterior mediastinum. I am reporting 1 case (Case 2) of these 4 in detail in this paper. In 2 cases, the tumors were cellular fibromata, one was in the upper and one in the lower part of the thorax. Both of these were very large tumors. One involved the upper half of the thorax, was cystic, and had been treated as a tuberculous pleural effusion. In the other case the tumor involved the posterior, lower third of the thorax and was accompanied by



Fig. 14. Roentgenogram on admission at time of first visit of patient. Destruction of half of the fifth, sixth, and seventh left thoracic vertebrae is seen. Case 5.

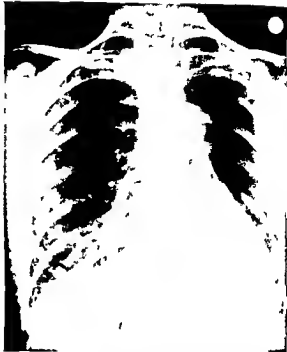


Fig. 15. Roentgenogram following injection of lipiodol into the spinal canal with partial obstruction at the site of the tumor. Case 5.

a bloody pleural effusion which was thought to be due to malignancy. This is the only case in which I have seen a benign tumor associated with bloody pleural effusion.

There were 4 cases of teratoma. In 2 the tumors were of definite dermoid type, one of which involved the entire thorax. The latter case (Case 1) is reported more in detail in this paper. In 1 case the tumor contained thymic tissue and in the other the growth consisted almost entirely of cartilage, bronchi, and embryonic structures resembling pulmonary tissue.

All of these tumors were in the anterior mediastinum, were fixed, and lay over the great vessels and upper portion of the pericardium, with a projection extending under the arch of the aorta. They were extremely adherent to all of the surrounding structures. Three of the tumors, although they extended more into one side of the thorax than the other, were adherent to the pleura of both pleural cavities. In one instance, both pleural cavities were opened in the course of removal of the tumors. I believe that all intrathoracic

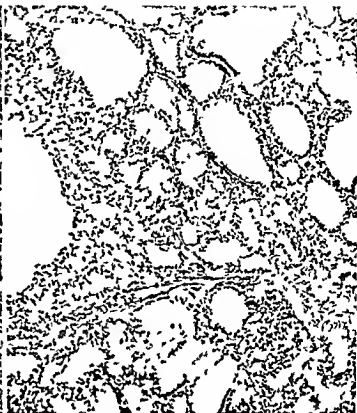
tumors should be considered potentially malignant. The teratomata are more likely to undergo malignant degeneration than any other type of benign tumors.

There were 2 cases of chondroma, 1 of which occurred the only operative death in the entire group of benign tumors. This latter case (Case 3) is reported later in this paper. The tumor was huge, practically filling the entire thorax, and a large mass protruded through the thoracic wall. Death was due to the extensive type of operation which was necessary, in a patient who was *in extremis*. This case exemplifies the importance of early operation in all cases of benign tumor before serious injury from pressure has been done to surrounding structures. These injuries may cause death.

These cases of benign tumor are the most gratifying from a surgical standpoint, for the risk is not great if the tumors are removed before they have become so large as to cause pressure on the surrounding structures. If the patient survives the operation, complete cure is obtained. The frequency with which



Fig 16 left Tissue from the thyroid gland. Adenocarcinoma, graded 2, in a colloid and fetal thyroid gland. Case 5



2, of the thyroid type. Differentiation into columnar epithelium has taken place to a large extent. The specimen bears a close resemblance to an exophthalmic goiter. Case 5

these benign tumors become malignant is the most significant indication for their early surgical removal. Because of the difficulty in establishing a definite clinical diagnosis, I believe that exploration should be done in all cases unless the clinical evidence is that a hopeless inoperable condition exists.

#### REPORT OF CASES

**CASE 1.** A woman, aged 18 years, consulted the clinic July 22, 1929, complaining of pain in the left side of the thorax of 6 months' duration. There was nothing in her history or the family history referable to her present complaint. She had had good health until 2 weeks after childbirth, 6 months before she entered the clinic, when a sudden attack of severe pain had developed in the left side of the thorax and beneath the sternum, this had been associated with dyspnea. She had not had fever and the condition had been diagnosed as pleurisy of the left side. The pain had been more or less constant since its onset with several exacerbations of severe pain associated with dyspnea. There had been a constant sensation of pressure beneath the sternum, with pain radiating to the left side of the thorax, associated with a dry, non-productive cough. This cough was most noticeable on exertion, and she

had noted a slight tinge of blood in the sputum when she had a cold. The immediate reason for the patient coming to the clinic was pain in the right lower quadrant of the abdomen which had been diagnosed as due to acute appendicitis. She had had an indefinite pain in the right lower quadrant for the last 2 years.

General examination revealed that the patient had lost 10 pounds in weight in the last 6 months. She appeared pale, fairly well nourished, and had a hectic flush. The systolic blood pressure was 135 and the diastolic 90, measured in millimeters of mercury. The pulse rate was 124 and the temperature, 99.4 degrees F. Percussion disclosed dullness to flatness throughout almost the entire left side of the thorax with some hyperresonance at the apex of the left lung. Auscultation revealed almost complete absence of breath sounds, and some rales scattered throughout the left side of the thorax. The heart was markedly displaced to the right and heart sounds were almost entirely absent from the left side of the thorax. The liver extended about 7.5 centimeters below the right costal margin. There was also a large palpable node in the left axilla, probably inflammatory. Roentgenological examination on admission showed markedly increased density over the entire left side of the thorax, to the level of the first rib, probably this was due to a tumor with fluid. The heart was markedly displaced





Fig 18 Roentgenogram made on admission (lateral view). The large intrathoracic and extrathoracic tumor is seen in the middle portion of the thorax. The intrathoracic portion extends half way to the spinal column. Case 6

to the right. A clinical diagnosis was made of a large tumor of the left side of the thorax, pleural effusion, pulmonary collapse and displacement of the heart to the right (Fig. 1).

Diagnostic aspiration of the left thoracic cavity was done July 27 and about 1,500 cubic centimeters of brown turbid fluid containing erythrocytes and crystals of cholesterol was removed. Roentgenological examination following this procedure showed a large left intrathoracic tumor, partial pulmonary collapse and moderate displacement of the heart to the right. July 31, pleurocentesis and artificial pneumothorax were performed on the left side with removal of 1,250 cubic centimeters of brownish fluid and replacement of 1,250 cubic centimeters of air. August 3, pleurocentesis and artificial pneumothorax again were performed on the left side, 750 cubic centimeters of brownish fluid was removed and 1,000 cubic centimeters of air was inserted. Roentgenological examination after the removal of 3,000 cubic centimeters of fluid from the cyst and insertion of 2,250 cubic centimeters of air into the left thoracic cavity disclosed a large cystic tumor almost completely filling the left thoracic cavity, with the level of intracystic fluid at the lower third of the tumor. The walls of the tumor were definitely outlined. The lung was completely collapsed posterior to the tumor. There was a small amount of fluid in the cardiophrenic angle of the thoracic cavity. The

lateral view taken 9 days later, revealed the saccular tumor occupying most of the left thoracic cavity and apparently originating in the anterior mediastinum. The level of the intracystic fluid had risen to about the middle of the tumor. A diagnosis was made of left intrathoracic cystic teratoma filling the entire left thoracic cavity with complete collapse of the left lung (Figs. 2 and 3).

August 18, under intratracheal ethylene anesthesia, left posterior thoracotomy was performed with removal of the entire seventh rib and sections of the fifth, sixth and eighth ribs. On exposure of the left thoracic cavity, a huge semicystic tumor was seen filling almost the entire left side of the thorax. The tumor was 30 by 20 by 18 centimeters. The upper portion of the wall of the cyst was thin and the lower portion very thick. One large projection extending under the arch of the aorta was adherent to the arch of the aorta and pericardium. These adhesions were firm and had to be dissected free with a knife. The tumor was ruptured during its removal. It contained about 2,000 cubic centimeters of clotted blood and fluid containing particles of hair. The entire wall of the cyst was removed with the exception of a few fragments extending under the arch of the aorta. The lung had been completely collapsed apparently for a long time and was adherent to the anterior wall of the thorax and to the tumor. These adhesions were separated and the lung was allowed to drop back into its normal position. The thoracic cavity was washed out with physiological solution of sodium chloride. The lung was reinflated as soon as the tumor was removed and was kept inflated until the wound was closed. The thoracic cavity was drained by intracostal closed drainage through the seventh interspace. The lung was in a thoroughly inflated condition at the completion of the operation. A transfusion of 500 cubic centimeters of blood was given while the patient was on the operating table. The thoracic cavity was drained with a No. 18 French catheter. Pathological study of the tumor revealed a cystic teratoma containing fluid, clotted blood and sebaceous material, the wall of the cyst contained hair, bone, fibrous connective tissue, muscle, mucus-secreting glands and sebaceous glands (Fig. 4).

The patient's immediate convalescence was stormy. Her pulse rate was 160 and respirations varied from 30 to 40, her temperature was 102 degrees F. The first day following operation she was given a second transfusion and placed in the oxygen chamber where her pulse rate dropped to 120, her respirations to 24 and her temperature to 100 degrees F. Her condition remained about the same but with gradual improvement. On the eleventh day a second tube was placed in the ninth interspace for better drainage of the thoracic cavity. Following this her temperature dropped to normal and her pulse rate to 100. From this time on her condition gradually improved. On the fourteenth day the fluid became purulent and the drainage tube was irrigated with Dakin's solution. The empyema cavity became gradually re-

duced in size, and there has been gradual re expansion of the lung to practically complete volume. There has also been marked improvement in the patient's general condition and she has gained about 20 pounds since the operation. She is completely relieved of symptoms of which she complained previous to operation and has no subjective symptoms at present.

This case is of particular interest because of the size and type of tumor and the difficulties encountered in making a definite clinical diagnosis. It is the largest intrathoracic tumor which I have removed. It almost completely filled the left thoracic cavity. Artificial pneumothorax is of great aid in determining the situation of the tumor, and in this case it showed the lung to be entirely collapsed posterior to the tumor and the tumor to be originating in the anterior mediastinum. The preliminary aspirations revealed that the tumor was cystic and the lateral roentgenogram showed the tumor to originate in the anterior mediastinum. This is the fifth teratoma which I have removed. In 4 of these cases, the tumor had originated in practically the same situation in the anterior mediastinum, firmly attached to the pericardium, to the great vessels, and to the arch of the aorta and pulmonary artery with an adherent projection extending beneath the arch of the aorta into the lower cervical region. This tumor had become so large that it had extended laterally into the left side of the thorax, almost completely filling the thoracic cavity and compressing the lung posteriorly. The greatest technical difficulty was in removing the tumor from structures in the anterior mediastinum, and from the lung, without causing serious injury to them. Because of the firm adhesions, it was impossible to remove the tumor intact. I believe that in these cases drainage should always be established, for in a high percentage of cases empyema develops as it did in this case. The operative procedure was complicated by collapse of the lung and by the fact that it was necessary to dissect the portion of the cyst from the pericardium which was causing serious cardiac embarrassment. It was impossible to reinflate the lung every 3 to 5 minutes, as we usually do in these cases, because of the compression of the lung by the tumor. It is always advisable



Fig. 19. Photograph of patient on admission. A large tumor of the right anterior portion of the thoracic wall is seen beneath the scar of the previous radical amputation of the breast. Case 6.

to give some type of intravenous treatment following an operation of this magnitude, either physiological solution of sodium chloride or blood. The administration of oxygen is of great value in the immediate convalescence.

**CASE 2.** A woman, aged 53 years, consulted the clinic July 15, 1929, complaining of exhaustion. She had had good health until pneumonia of the left side had developed 4 years before at which time she had been in bed for 2 weeks. She had felt fairly well thereafter until 1½ years before she came to the clinic, when influenza had developed. She had been more than a month regaining her strength. During this time, severe, sharp pains "in both lungs" had appeared on deep breathing or on coughing. She had had a temperature of 102 degrees F and a roentgenogram had given evidence of pleural effusion. The thorax had been strapped. She had been in bed for about 1 week immediately thereafter and at frequent intervals in the following month. She had not entirely regained her strength since that time. She became tired easily. There was some cough but no expectoration. Six months previous to her admission she had had influenza with a moderate cough and pain on deep breathing. A diagnosis of pleurisy had been made again and her thorax had been strapped. The condition had cleared up after 2 weeks. Since that time she had suffered marked loss of strength, had become exhausted easily, and had had a slight non-productive cough.

General examination gave essentially negative results. The patient's weight was 109 pounds and her



Fig 20. Roentgenogram taken after artificial pneumothorax. There are a few adhesions of the right lung to the upper portion of the intrathoracic tumor. No lesion is seen in the lung. Case 7.

height 5 feet and 6 inches. The concentration of hemoglobin was 80 per cent, erythrocytes numbered 4,940,000 and leucocytes 7,600 in each cubic millimeter of blood. The Wassermann reaction of the blood was negative. The basal metabolic rate was +5 per cent. Roentgenological examination revealed a circumscribed shadow in the region of the right portion of the mediastinum, at the level of the fourth and fifth ribs posteriorly. It was thought to be due probably to metastasis. Operation was advised, but because the patient was weak, she decided to go home and return in 2 months for operation.

The patient returned September 17, 1929, at which time her symptoms were essentially unchanged. There was some increase in the cough but it was non-productive. The complaints of chronic nervous exhaustion were about the same. Roentgenologic examination at this time disclosed apparently no change in the size of the tumor. A diagnosis was made of postinfectious exhaustion with associated right intrathoracic neurofibroma (Fig 5).

September 21, 1929, under intratracheal ethylene and ether anesthesia, right posterior thoracotomy, with removal of 15 centimeters of the fifth rib and section of the fourth rib was performed. Transpleural complete removal of the neurofibroma from the upper portion of the posterior mediastinum was effected without difficulty. On exposure of the right thoracic cavity a small neurofibroma, measuring 4,

3, and 3 centimeters in various diameters, was seen in the upper portion of the posterior mediastinum at the level of the third interspace. It was attached to the body of the vertebra at the angle of the spinous process and the vertebra. The thoracic aorta was just to the left of the tumor. The lung was very adherent at various points to the entire parietal pleura. These adhesions were not separated and probably were the result of the repeated attacks of influenza of which the patient had complained. The fourth rib was sutured, the lung was reinflated and the thoracic cavity was closed without drainage. The pathologist reported neurofibroma weighing 28 grams.

There was very little reaction following operation. On the second day, the temperature was 100 degrees F and the pulse rate 100 each minute. The temperature dropped to normal on the fourth day and the pulse rate to 90. There was a small amount of pleural effusion which did not require aspiration. The patient was dismissed from the hospital and from observation on the twenty-eighth day after operation at which time the wound was entirely healed and the roentgenological examination gave evidence that the lungs were completely re-expanded and that no fluid had accumulated.

This patient returned 2½ months after operation for re-examination before going to a warmer climate because of the repeated respiratory infections. There was little change in her general condition and she continued to have a dry cough. Her appetite was better and her general condition was good. It was felt that her generally run down condition had resulted from repeated pulmonary infections of which the tumor was not a contributing factor. The slight improvement which was obtained in the general condition was due to the fact that she ceased worrying about the tumor, which she had feared was malignant. From an operative standpoint the convalescence was uneventful. She was up on the eighth day after operation and had practically no disturbances except moderate difficulty on deep breathing from the fourth day. A slight amount of pleural effusion developed but this was gradually absorbed without aspiration, which is usually the case unless there has been considerable trauma to the pleura (Figs 6 and 7).

CASE 3. A man, aged 56 years, consulted the clinic June 3, 1929, complaining of tumor of the right side of the thorax, and dizzy spells of 3 years' duration. He stated that 3 years before, he first had noticed a small tumor, about 2.5 centimeters in diameter on the upper right wall of the thorax. It was hard and had seemed fixed to the rib. Its growth had been gradual, and in about 1 year it had attained a size of about 6 by 4 by 4 centimeters. In 2 years the tumor had been about 8 centimeters in diameter. In the last year, its growth had been more rapid, until at the time he came to the clinic it involved practically the entire right half of the thorax. The patient had lost neither weight nor strength. In the last 6 months he had had a more or

less constant dull pain over the tumor and between the shoulder blades. Dyspnea on exertion had been noted, and for the month before he was seen at the clinic, the patient also had noted pain in the right side of the thorax on deep inspiration. He first had noted a dry, brassy cough 3 months before he sought advice. This had become progressively worse and for the month previous to admission, bright red blood had been expectorated after a severe coughing spell. About 3 years previous to admission the patient had been refused life insurance because of high blood pressure, the systolic pressure had been 240 millimeters of mercury at that time and thereafter had varied from that level to 180 millimeters of mercury. The patient had been treated for hypertension by diet, medicine, and physiotherapy. He had had frequent headaches and dizzy spells, and his vision was poor.

General examination revealed the patient's weight to be 130 pounds. The pupils were slightly irregular, their reaction was normal, and early arcus senilis was present. The heart was enlarged to the left and there was a systolic murmur, there was marked sclerosis of the peripheral vessels. The systolic blood pressure was 245 and the diastolic, 130. The pulse rate was 78. There was a large mass involving practically the entire right thoracic cavity, it was firm, fixed, and slightly pulsile. Urinalysis gave essentially negative results. The concentration of blood urea was 24 milligrams in each 100 cubic centimeters. The concentration of hemoglobin was 70 per cent, erythrocytes numbered 4,800,000, and leucocytes 7,200 in each cubic millimeter of blood. The Wassermann reaction of the blood was negative. Reflexes of the eyes were normal, the visual fields were roughly normal. Sclerosis of the retinal arteries was graded 2 and hemorrhages were seen in the fundi. Electrocardiograms disclosed a cardiac rate of 78, sinus rhythm, very slight left ventricular preponderance, diphase T waves in derivation 3, exaggerated P waves in derivation 2, notched P waves in derivations 1, 2, and 3, slurred QRS complexes in derivations 1, 2, and 3, and variable amplitude of the P waves in derivation 3. Roentgenologic examination gave evidence of an intrathoracic tumor filling the upper two-thirds of the right thoracic cavity and resting on the spinal column posteriorly. There was a large protrusion through the anterior thoracic wall with destruction of the second, third, and fourth ribs anteriorly (Figs 8 and 9). A diagnosis was made of a large intrathoracic fibromyxochondroma filling the upper two-thirds of the right thoracic cavity and protruding about 12.5 centimeters through the anterior thoracic wall with complete collapse of the upper and middle lobes of the right lung. Partial collapse of the lower lobe of the right lung also was noted.

Before a radical operation was done, a specimen was removed for diagnosis from the portion of the tumor which protruded through the anterior thoracic wall. This proved to be fibromyxochondroma. It was thought best to attempt complete removal of

the tumor. July 3, 1929, under intratracheal ethyl ene and ether anesthesia, right posterior mediastinotomy was performed with resection of a portion of the sixth rib and section of the seventh, fifth, fourth, and third ribs, posteriorly.

On exposure it was found that the tumor filled at least two-thirds of the cavity. The upper and middle lobes of the right lung were completely collapsed and flattened out over the surface of the tumor. The tumor filled the entire right side of the thorax anteroposteriorly and was pressing on the spinal column posteriorly. There was partial collapse of the lower lobe of the lung. The lung was so adherent over the capsule of the tumor that it was practically incorporated into the capsule in several places. It had ruptured into the lung, forming multiple small fistulas. The pulmonary tissue was separated from the surface of the tumor and was permitted to drop back. It was then found that the tumor was very adherent to the pericardium and to the mediastinal pleura of the left side. These adhesions were separated. After the intratracheal portion of the tumor had been separated, it was found that it was firmly attached to the third and fourth ribs anteriorly, which had been partially destroyed, and that the tumor apparently had originated from the cartilages of these two ribs. A small segment of each rib was excised, including the cartilages, and the entire intrathoracic tumor with that portion projecting through the thoracic wall was completely removed, that is, transpleural complete removal of the intrathoracic and extrathoracic tumor.

The lung was reinflated several times during the operation, and in spite of its marked compression, it seemed to be in good condition except for the small fistulas which were present, probably due to pressure. The thoracic cavity was washed out with physiological solution of sodium chloride, and the cavity was closed with intrathoracic drainage using a No. 30 French catheter. At the completion of the operation the patient was given a transfusion of 500 cubic centimeters of blood. The pathologist reported degenerating fibromyxochondroma weighing 1,844 grams.

The blood pressure had dropped to 100 and the pulse rate was 98 at the completion of the operation. The blood pressure gradually increased to 145, 6 hours after operation and the condition of the patient was satisfactory. The following morning the blood pressure began to fall rapidly, with rapid increase in the pulse rate. The patient died within 10 minutes, essentially from cardiac causes.

Necropsy revealed hypertrophy of the heart (505 grams), probably the result of hypertension, and bronchopneumonia of the right lung, with atrophy of the kidneys (arterio-sclerotic type). The tumor had been completely removed.

This case presents several points of extreme interest and importance. The most significant are that the tumor was benign and had been

permitted to grow until the patient was *in extremis*. Operation became imperative, and the risk was greatly increased because of the size of the tumor, particularly the intra thoracic involvement, with compression of the lung. This operative risk also was greatly enhanced by the marked general arteriosclerosis with hypertension, the cardiac hypertrophy, and the age of 56 years. I believe that these tumors should be removed before they have resulted in such marked intra thoracic involvement, with adhesions to the lung and to structures within the thorax.

**CASE 4.** A woman aged 32 years first consulted the clinic December 10, 1926, complaining of pain in the left upper portion of the thorax of 3 years duration. She had had good health until 3 years previous to her visit to the clinic when she had begun to have a dull pain in the upper left part of the thorax which had increased when she had become tired or excited. She had noticed the pain mostly at night. It had increased and occasionally had been present during the day. The patient had been short of breath but this complaint had not increased. The pain had not radiated. There had not been any cough or expectoration. She had not noticed loss of weight. Ten months previous to her admission she had had a swelling in the right side of the neck which had been thought to be a cyst, and had been removed. Two months previous to admission a node had been removed from the neck and had been diagnosed as being tuberculous.

General examination at the time of the patient's first admission gave essentially negative results. Roentgenological examination revealed a dense circumscribed shadow in the left upper posterior portion of the thorax at the level of the fourth and fifth ribs posteriorly. Apparently the cause of the shadow was benign (Fig. 10). The patient decided not to have an operation at this time.

The patient returned 5 months later stating that during her absence her condition had been as good as it had been previously. She had an occasional pain in the left side of the thorax anteriorly at times going through to the upper part of the spinal column. Cough or hemoptysis had not been noted. There had been no loss of weight and she weighed, at this time, 132 pounds, which was 3 pounds more than at her last visit. The roentgenogram, at this time, gave no evidence of change in the size of the tumor since her previous visit. The patient again returned home without treatment (Fig. 11).

The patient returned again August 5, 1929, stating that her general health had been normal until 6 months previous to her visit, when she had begun to notice loss of strength and that she became fatigued easily. The pain in the left side of the thorax had become much more marked 2 months prior to admis-

sion and had been progressing rapidly, it had been severe for 1 month previous to admission. Because of the marked increase in the severity of the pain, the patient had returned to the clinic. The pain was situated in the left shoulder, spinal column, and axilla. It was made worse by exercise and was somewhat relieved by rest. Cough or hemoptysis was present. There was loss of weight of 6 pounds in 2½ months and marked loss of strength also had been noted.

General examination gave essentially negative results. The roentgenological examination revealed a circumscribed tumor on the left side of the upper mediastinum, between the third and seventh interspaces, posteriorly. The tumor contained a small amount of calcification and had increased almost threefold in size since the first examination (Fig. 12). The diagnosis was made of a left intrathoracic fibromyxochondrosarcoma originating at the angle between vertebrae and ribs at the level of the fourth and fifth ribs.

August 10, 1929, under intratracheal ethylene ether anesthesia, left posterior thoracotomy was performed with removal of the fifth rib and section of the sixth, fourth and third ribs. On exposure a large solid tumor was found measuring 10, 9 and 6 centimeters in various diameters and firmly attached to the posterior thoracic wall. Its origin had been at the angle between the vertebrae and the ribs at the level of the fourth and fifth ribs and apparently had originated at the juncture of the fifth rib and the vertebra. There was a projection of the tumor into the mediastinum, between the arch of the aorta and the first portion of the descending aorta. It was this portion of the tumor that malignant change had been found. The tumor was very adherent to the aorta at this point. Transpleural removal of the entire tumor was effected and the thoracic cavity was washed out with physiological solution of sodium chloride to remove the blood clots. The thoracic cavity was closed without drainage. The pathologist reported a hemorrhagic degenerating fibromyxochondrosarcoma, associated with a hamangioendothelioma weighing 220 grams (Fig. 13).

The patient stood the operation satisfactorily, and there was only moderate reaction. The pulse rate on the second day was 130 and the temperature 101 degrees F. The temperature gradually dropped to normal on the fourth day after operation and the pulse rate to 100. A pleural effusion developed which required aspiration on four occasions. The patient was dismissed from the hospital and from my care September 23, 34 days after operation with the wound completely healed in good general condition.

The patient returned for observation 1 month after dismissal complaining of pain in the left shoulder which had become increasingly more severe. The pain had been most marked at night and she had been unable to sleep because of it. There also had been some pain and difficulty in swallowing. The pain had been in the upper part of the thorax, the left shoulder and back as it had been prior

the operation. Roentgenological examination revealed evidence of partial collapse of the lung, and a small amount of fluid at the base. It was thought that the patient's condition was due to recurrence of the tumor, and she was given treatment by roentgen ray. She again returned, 1 month later, with no relief of symptoms. The pain had become worse, with increase in difficulty in swallowing. A non-productive cough also had developed. The pain had been so severe that sedatives had been required for relief. Her condition became gradually worse and she died January 2, 1930, 5 months after the operation.

This case is of particular interest because there is reason to believe that the tumor was primarily benign but that later it underwent malignant change. It is unusual to have a patient with tumor under observation for this period of time, but the first roentgenogram, taken in 1926, compared with those taken 5 months later, did not disclose evidence of increase in the size of the tumor, and there was no increase in the clinical symptoms for 2½ years. There then was rapid increase in the severity of the pain, to a point that sedatives were required in 2 months' time. Pain was the predominant symptom throughout, which usually is the case in malignant tumors. The possibility of this being a benign tumor originally is also suggested by microscopic study of the tissue, for the greatest portion of the tumor was composed of benign tissue. That portion of the tumor which extended into the posterior mediastinum, underneath the great vessels, had been affected by a malignant change of a very high grade. The marked increase in the size of the tumor at the time of the patient's last visit to the clinic also was suggestive of a malignant condition. In the former roentgenograms, no change in size had been evident. Because of the high grade of malignancy and the extension of the tumor into the posterior mediastinum, the prognosis was grave, for the tumor probably had metastasized to the deeper structures of the mediastinum at the time of operation. Neither the operation nor the roentgen-ray treatment influenced the progress of the disease.

**CASE 5.** A woman, aged 35 years, consulted the clinic October 31, 1923, because of a goiter which had been present for 15 years and which had increased in size about 10 years prior to admission. There were no general symptoms except that she

had become tired more easily than usual during the 6 months previous to her arrival at the clinic. She had been treated for pulmonary tuberculosis 8 years and 6 years previous to the time I saw her, but bacilli of tuberculosis had never been found in the sputum. Examination gave essentially negative results except for the revelation of the adenomatous goiter without hyperthyroidism. Roentgenograms of the thorax gave evidence of an old, calcified tuberculous lesion at the apex of the left lung. Thyroidectomy was advised, and was performed November 6, 1923. Microscopic examination of the goiter disclosed adenocarcinoma, graded 2, in a colloid and fetal thyroid gland.

The patient returned September 11, 1929, because of a severe pain in her back of 1 year's duration. She had had an indefinite pain in the epigastrium and back, and indigestion for 3 years previous to her second visit. She had been operated on elsewhere for disease of the gall bladder, without stones, but the gall bladder had been found to be normal. The appendix had been removed and the round ligaments of the uterus had been shortened. There had been no improvement in her condition for about 1 month, but she had had more or less constant trouble since that time with indigestion and pain in the back and epigastrium. For the year before her second visit, her symptoms had been getting progressively more severe and the pain in her back had been the most prominent symptom. This had been constant and dull, with acute attacks of sharp pain which had radiated around both sides of the lower dorsal portion of the thorax, to the epigastrium, and had been more marked on the left side. She had noticed some twitching in the muscles on the left side. The severe attacks of pain had occurred more often at night and had been followed by vomiting in many instances. She had had some difficulty in swallowing solid food for the 9 months previous to admission. There had been marked weakness and loss of strength. She had lost 20 pounds in 4 to 6 weeks. There was also a dry cough of several months' duration and shortness of breath of 15 months' duration.

General examination disclosed a lesion of the fifth, sixth, and seventh thoracic vertebrae. There was bilateral root pain and there had been some paresthesia and urinary disturbance. Urinalysis revealed only a few pus cells. The concentration of haemoglobin was 116 grams in each 100 cubic centimeters of blood. The Wassermann reaction of the blood was negative. Leucocytes numbered 6,200 in each cubic millimeter of blood. The vocal cords functioned normally. Roentgenological examination gave evidence of marked destruction of the left half of the fifth, sixth, and seventh thoracic vertebrae due to erosion caused by tumor, probably neurofibroma. Fluoroscopic examination of the aorta and oesophagus gave negative results (Fig. 14). The roentgenographic shadow was very regular in outline, and suggested the possibility of a benign type of tumor. Because of the type and severity of the pain, and the old history of a carcinoma of the thyroid gland,

a clinical diagnosis of metastasis to the spinal column was made. It was thought best to keep the patient under observation for a month or 6 weeks to note progress and to see if time would make a differential diagnosis possible. Considering the rapidity of increase in the recent symptoms it was thought that if the condition were due to metastasis of a malignant growth in a month the diagnosis could be definitely established and operation avoided. The patient returned in 3 months with marked improvement in her general symptoms. She had gained 8½ pounds in weight. The pain in the abdomen had disappeared. She could eat practically everything except cabbage and the pain in the back, although still present, was not so severe. The cough was about the same. Roentgenograms of the spinal column did not give evidence of change in the size of the tumor but possibly slight increase in destruction of the sixth vertebra. Lipiodol was injected into the spinal canal and some evidence of obstruction at the level of the tumor was seen. The second day following the injection of the lipiodol the patient began to have pain in the left leg. The pain was of moderate severity, weakness and loss of strength of the muscles gradually developed and for several days the patient was unable to be on her feet more than 10 to 15 minutes at a time. The reaction gradually subsided and was entirely gone in about a week. There was less pain in the back following the spinal puncture. Because of the improvement in her general symptoms and the absence of any definite growth of the tumor exploratory mediastinotomy was advised (Fig. 13).

January 18, 1930 under intratracheal ethylene and ether anesthesia posterior left mediastinotomy was performed. A posterolateral incision was made a portion of the sixth rib was removed posteriorly and the periosteum was excised. Transpleural exploration of the thoracic cavity was performed. There was a mass extending about 2.5 centimeters above the level of the arch of the aorta and extending underneath the descending aorta for about 6 centimeters. It was necessary to displace the descending aorta to the right to remove the tumor which was posterior to it. The tumor was very vascular and infiltrated the surrounding tissues. Grossly it appeared to be malignant. It was partially removed. Bleeding was controlled and the thoracic cavity was closed without drainage. An operative diagnosis was made of metastatic carcinoma involving the fifth, sixth and seventh thoracic vertebrae with the tumor projecting backward and to the left of the arch of the aorta and the upper part of the descending aorta. The pathologist reported adenocarcinoma graded 2. The tumor was of the thyroid type for its cells had differentiated into columnar epithelium to a large extent so that the growth bore a close resemblance to an exophthalmic goiter (Figs. 16 and 17).

Convalescence was uneventful except for slight pleural effusion which did not require aspiration. The patient was given treatment by radium on the

twelfth day after operation and was dismissed from my care on the twenty fifth day, at which time the wound was entirely healed.

This case is of particular interest because of the unusual symptoms and course of the disease, the difficulty in establishing a definite clinical diagnosis, and the rarity of metastasis to the spinal column of carcinoma of low grade of the thyroid gland. The severity and type of the pain in the back suggested root pains of the upper thoracic nerves. The epigastric pain and digestive disturbances, with vomiting, suggested vagal irritation due to malignant infiltration which later had gone on to complete destruction of the vagus nerve, with relief of the digestive disturbance and improvement in the patient's general condition. This probably explains her improved general condition when she returned after 3 months, and the change in the quality of her voice probably was due to involvement of the left recurrent laryngeal nerve where it passed around the arch of the aorta. Aneurism was ruled out by fluoroscopic examination and absence of clinical signs. The roentgenological features were more suggestive of a benign than a malignant lesion. The sharply defined, rounded contour of the intrathoracic portion of the tumor suggested neurofibroma. There was more destruction of the spinal column than usually is found in benign lesions, scoliosis was present. There also was more marked obliteration of the intravertebral disks than usually is seen in benign lesions. There is very little risk to exploratory thoracotomy, and I believe that it should always be done in cases of this type, when a definite diagnosis cannot be made between malignant and benign tumors, because approximately 50 per cent of the lesions in this region are benign.

**CASE 6.** A woman aged 46 years, consulted the clinic August 20, 1929 in regard to a tumor of the right thoracic wall of 12 months' duration. Five years prior to her visit to the clinic, the patient first had noted a small tumor in the upper central quadrant of the right breast. The tumor was fixed and did not move freely with the breast. She had been kept under observation by her home physician for 1 year, but definite growth of the tumor had not been noted. Because of slight pain in the tumor she had been given bimonthly roentgen ray treatment for the next 2 years and 2 years prior to her coming

to the clinic radical amputation of the right breast had been performed. About 1 year after the operation she first had noticed a small tumor, fixed to the rib just to the inner side of the scar. The growth had been gradual for 9 months, but more rapid for the next 3 months until at the time she came to the clinic it was larger than the opposite breast. Roentgen ray treatment had been given for 2 weeks prior to her visit and the tumor had increased in size in spite of the treatment. Her general condition was good. There had been no loss of weight, there was no swelling of the arm and her appetite was good.

General examination gave essentially negative results except for disclosing the large, fixed tumor of the right anterior portion of the thoracic wall, with dark red discoloration of the skin over it and the scar of the previous radical operation. There was no regional adenopathy. Urinalysis gave negative results. The concentration of hemoglobin was 78 per cent, erythrocytes numbered 5,050,000 and leucocytes, 7,100 in each cubic millimeter of blood. The Wassermann reaction of the blood was negative. Roentgenological examination gave evidence of a dense tumor in the middle of the right lower anterior portion of the thorax, arising from the mediastinum. A lateral view indicated that the tumor was large, was both intrathoracic and extrathoracic, and that it involved the midthoracic region. The intrathoracic portion extended half way to the spinal column. A clinical diagnosis was made of a tumor of the right thoracic wall, that probably was a recurring carcinoma of the right breast (Figs 18 and 19).

August 28, 1929, under intratracheal ethyl chloride and ether anesthesia, anterior thorotomy, with partial removal of the third and fourth ribs, was performed. Because of the marked discoloration of the skin over the tumor anteriorly, it was thought best to make an anterior incision. The tumor was found to arise at the junction of the cartilage of the third and fourth ribs anteriorly. There was considerable destruction of the ribs proximal to the cartilage. The ribs were resected well away from their region of degeneration, and the intrathoracic portion of the tumor was removed down to the parietal pleura which was left intact. It was difficult to close the skin because of the scar from the previous operation and the depletion of the blood supply of the skin from frequent roentgen ray treatment. The tumor measured 17, 14, and 5.5 centimeters in various diameters. An operative diagnosis was made of a large fibrosarcoma of the right anterior thoracic wall, with large intrathoracic extension, and the pathologists reported the tissue removed to be a fibrosarcoma, graded 1, in a fibromyoma.

The patient's convalescence was uneventful, except for necrosis of the skin along the margin of the incision. She was dismissed from the hospital on the eleventh day after operation and from my care October 21, 1929, about 7 weeks after operation. The delay was due to the sloughing of that portion of the skin which was over the tumor. At

the time of her dismissal the wound was granulating at the base and it had almost healed. She was advised to return in 2 to 3 months for observation and for roentgen ray treatment.

This case is of interest because it is probable that the original tumor which had been thought to be in the breast was in the anterior thoracic wall, for the patient stated that she had been able to feel a small tumor immediately after the operation on the breast. This may have been primarily a chondroma, for there was practically no growth in the tumor for  $4\frac{1}{2}$  years. It suddenly began to increase rapidly in size, which would indicate sarcoma with degeneration. It is not uncommon when abnormal conditions are immediately beneath the tissue of the breast to have them simulate tumors of the breast. I have seen 2 cases in which the complaint was of tumor of the breast, which proved to be instances of tuberculous abscess of the wall of the thorax underneath the breast. The prognosis in this case should be fair because of the low grade of the sarcoma. I believe that the prognosis would be very much better had the tumor been removed while it was in the dormant state.

CASE 7. A man, aged 48 years, consulted the clinic, January 27, 1930, in regard to a tumor of the right portion of the wall of the thorax which had been present for 2 years and 8 months. In May, 1927, 2 years and 8 months prior to his visit to the clinic, severe pain had developed suddenly in the right midaxillary line. The patient had had to stop work and had been taken home. He had been given a hypodermic injection to afford relief. The pain had been of a stabbing character and had necessitated morphine for 1 or 5 days. The pain had been augmented by inspiration, sneezing, or coughing. Following that attack the patient had had a dull, aching pain in this region with attacks of severe pain similar to that which had appeared at the onset. He had had moderate cough, with some expectoration of mucoid material, but without blood or pus. One and a half years before he came to the clinic pain had developed in the right lower part of the back, with some indigestion and he had been operated on for disease of the gall bladder. The gall bladder had been found to be normal. Two months previous to his consulting the clinic, severe pain in the right side of the thorax had suddenly developed again and gradually had grown worse, so that 15 grains (0.997 gram) of morphine had been required for relief. From then to the time the patient came to the clinic he had had more or less constant pain, for relief of which morphine and ether had been required. The most severe attack had lasted 2 days.



duction of foreign body giant cells, and that healing was markedly delayed. The scalpel incisions healed in 3 to 4 days, with very little scar formation and often by primary union. The cautery incision was not healed after 12 days. Healing was slow with extensive scar formation and with a tendency to infection. It must be remembered that the rat is unusually resistant to ordinary pyogenic infection.

In the second group of experiments, 14 rats were used. In 7, scalpel incisions, 1 centimeter in length, were made in the liver. There was considerable bleeding. In the remaining 7 rats similar sized incisions were made in the liver tissue with the electrocautery. There was practically no bleeding. The rats were killed at intervals of 1, 2, 3, 4, 6, 8, and 14 days and sections made of the liver wounds.

#### PROTOCOLS

*Rat 5* Scalpel incision 1 day after operation. There is a small wedge shaped cleft in the liver tissue filled with a clot. The surrounding liver tissue is intact.

*Rat 6* Electrocautery incision in the liver 1 day after operation. There is a large irregular area of necrosis. The edge of the necrotic area ends abruptly without any transitional zone. The surrounding liver tissue is deeply congested. There are small areas of hemorrhage in the necrotic region. The capsule on one side of the necrotic area is covered with a layer of desquamated endothelial cells. Just beneath the capsule there are large irregular spaces in the necrotic tissue indicative of dehydration (Fig. 4).

*Rat 7* Scalpel incision 6 days after operation. The wound is entirely healed. There is a small narrow wedge of dense fibrous connective tissue corresponding to the line of incision.

*Rat 8* Electrocautery incision 11 days after operation. The area of necrosis is very much smaller. It is practically replaced by a sharply defined area of granulation tissue. A few small areas of necrotic liver tissue are still present in the scar, surrounded by dense fibrous tissue and numerous foreign body giant cells. In addition there are numerous newly formed capillaries in the granulation tissue. The surface of the scar is depressed. There are still a few small areas in the necrotic spaces indicative of dehydration. The tissue about these spaces contains haemosiderin pigment (Figs. 5 and 6).

From the protocols and Figures 4, 5, and 6, it is evident that the electrocautery produces (1) extensive necrosis for some distance from the line of incision and (2) the necrotic tissue

acts as a foreign body, stimulating the formation of foreign body giant cells in the connective tissue about the area of necrosis. In the liver, the scalpel wound healed in short time, leaving a barely recognizable scar. Some advantage was found with the cautery in controlling the capillary bleeding in the liver. The liver is particularly susceptible to the necrotizing effects of the cautery.

In the third group, 12 rats were used. In one half of these, a single small incision was made in the spleen with the scalpel. In the other half a similar incision was made in the spleen with the electrocautery. The rats were killed at intervals of 1, 2, 4, 6, 8, and 14 days and the wounds sectioned.

#### PROTOCOLS

*Rat 9* Scalpel wound, 1 day after incision. There is a small wedge shaped cleft in the spleen filled with a blood clot. The surrounding tissue is normal (Fig. 7).

*Rat 10* Electrocautery, 1 day after incision. There is a large wedge shaped area of necrosis in the spleen. There is very little tissue reaction at the border of the necrotic area. On the surface, however, there is a large accumulation of polymorphonuclear leucocytes and fibrin (Fig. 8).

*Rat 11* Scalpel wound 6 days after incision. There is a very thin scar in the spleen extending from the capsule into the pulp. It consists of dense fibrous connective tissue in which are present a few round cells and haemosiderin pigment (Fig. 9).

*Rat 12* Electrocautery 8 days after incision. The irregular wedge shaped area of necrosis described in the earlier section is replaced in part by dense granulation tissue in which small islands of necrotic tissue are still present. About the areas of necrosis are numerous foreign body giant cells (Fig. 10).

From the protocols and the Figures 7, 8, 9, 10, it is seen that in the spleen as in the liver, skin, and striated muscles, extensive necrosis follows in the wake of the cautery. The necrosis acts as a foreign body, stimulating the formation of numerous foreign body giant cells after a period of 8 days. Healing is delayed.

In the fourth group, 12 rats were used. In half of these, small incisions were made in the right kidney with the scalpel and in the other half, a corresponding incision was made with the electrocautery. The rats were killed at intervals of 1, 2, 4, 6, 11, and 15 days and sections made of the wounds.



Fig 1 Extensive necrosis of skin 24 hours after cautery incision  $\times 65$



Fig 2 Numerous giant cells in specimen removed 11 days after cautery incision of skin  $\times 65$

#### PROTOCOLS

*Rat 13* Scalpel wound, 1 day after incision. Extending from the capsule to the medulla through the cortex, there is a narrow wound filled with a blood clot. The surrounding kidney tissue appears normal (Fig 11).

*Rat 14* Electrocautery wound, 2 days after incision. There is a large area of necrosis in the cortex, extending into the medulla. For a consider-



Fig 3 Photomicrograph of section removed 4 days after incision of skin with scalpel  $\times 65$



Fig 4 Liver specimen removed 24 hours after cautery incision showing necrosis and vacuolization  $\times 80$



Fig 5 Cautery incision of liver 11 days after operation showing foreign body giant cell reaction around zone of necrosis  $\times 80$

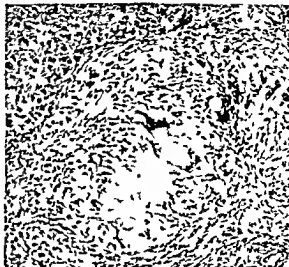


Fig 6 Giant cell formation 11 days after cauterization of liver  $\times 80$

able area on either side of the line of incision there is a zone of hemorrhage about the zone of necrosis. Close to the margin of the necrotic area the kidney

parenchyma is destroyed and replaced by a homogeneous, blood stained tissue. In the area of necrosis ghosts of kidney glomeruli and tubules are still visible. Beneath the capsule, the tissue is



Fig 7 Specimen removed 24 hours after scalpel incision of spleen  $\times 65$



Fig 8 Extensive necrosis 24 hours after cauterization of spleen  $\times 65$



Fig 9 Specimen removed 6 days after scalpel incision of spleen  $\times 65$

honeycombed with numerous cyst like spaces, indicative of extensive dehydration (Fig 12)

*Rat 15* Scalpel wound, 6 days after incision The line of incision is healed There is a thin band of scar tissue extending through the kidney

*Rat 16* Electrocautery, 15 days after incision There is an irregular wedge shaped area extending from the capsule to the medulla in which the kidney parenchyma is replaced by granulation tissue There are several areas of necrotic tissue in the granulation tissue These are surrounded by dense fibrous connective tissue which extends from the capsule inward The granulation tissue contains numerous fibroblasts, and about the areas of necrosis are many multinucleated foreign body giant cells In places these giant cells appear to be formed by the fusion of regenerating tubular epithelium (Fig 13)

From the protocols and Figures 11, 12, 13, it is seen that the cautery produces in the kidney as in other organs, extensive necrosis, a foreign body giant cell reaction evident after 10 days about the area of necrosis and marked delay in the healing and repair

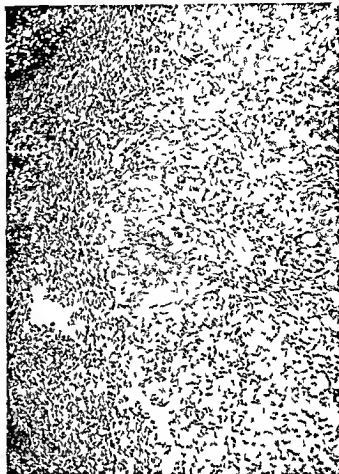


Fig 10 Foreign body giant cell reaction 8 days after cautery incision of spleen  $\times 65$

#### RESULTS OF OUR STUDY

It is obvious that the use of the electrocautery in normal tissue results in extensive necrosis The presence of necrosis produces a point of lowered resistance and encourages suppuration The necrotic tissue, even in the smallest incision, is sufficiently extensive to act as a foreign body and to stimulate the formation of numerous foreign body multinucleated giant cells In striated muscle they arise from the regenerating muscle sheath, in the liver from the reticular elements, in the spleen, where they are most numerous also from the reticular elements, and in the kidney they seem to arise from the epithelial cells of regenerating tubules It is of interest that in every organ they appear after a lapse of 8 or 9 days

The cautery incision heals slowly, for it produces extensive death of tissue and introduces elements that act to retard the process of repair

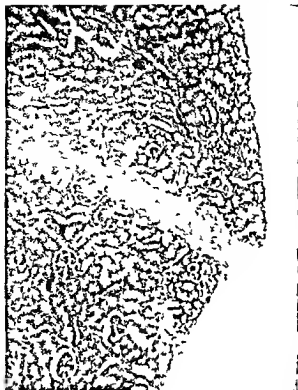


Fig 11 Specimen 24 hours after scalpel incision of kidney  $\times 110$

Another inherent danger in the use of the cautery is the occurrence of secondary hemorrhage. This may occur where the larger vessels are sealed with a coagulated mass

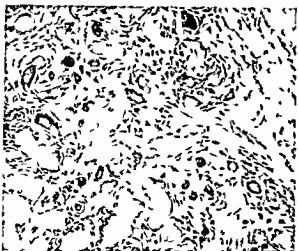


Fig 13 Giant cells 15 days after cautery incision of kidney  $\times 195$



Fig 12 Large area of necrosis 48 hours after cautery incision of kidney  $\times 65$

which becomes necrotic and may subsequently slough away. It must be remembered that we are here dealing with normal tissue. The results obtained suggest that more severe injury may result in diseased tissue following electrocautery. The use of the cautery in incising infected tissue is unsound and unphysiological, because it adds more necrosis to the burden of repair. Its promiscuous use for making incisions through healthy tissue is certainly to be discouraged.

The employment of electrocautery in cancer tissue has many drawbacks. The wounds heal more slowly and readily suppurate. It has been suggested that, by sealing the lymphatics, the method prevents the absorption of tumor cells and also destroys isolated foci along the line of incision. It is probable that immediate absorption is prevented by coagulation necrosis of the lymphatics cut across. Histological studies indicate that lymphatic channels rapidly regenerate in granulation

tissue Where wide excisions of malignant tissue is made, it is essential to resect the regional lymph nodes This blocks the lymphatic drainage Where all lymph channels are thus blocked, hrawny oedema results with resultant lowered tissue vitality The cautery only strengthens this vicious cycle

The use of the electrocautery is warranted, however, when it is definitely desired to destroy tissue, in places inaccessible to the scalpel and when the control of capillary bleeding is difficult The promiscuous use of the electrocautery, however, in lieu of the scalpel is to be condemned It has a definite place in surgical technique and should be used only when definitely indicated A knowledge of the pathological changes following in the wake of the electrocautery will help in evaluating its proper application

#### SUMMARY

A study of the effect of the electrocautery incision in the skin, muscle, liver, kidney, and

spleen in normal adult albino rats was made It was found that the electrocautery incision produces extensive necrosis which acts as a foreign body with a resulting foreign body giant cell reaction The advantages and the disadvantages of the electrocautery are discussed The promiscuous use of the electrocautery is to be discouraged

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PERINEPHRITIC ABSCESS<sup>1</sup>

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**B**ECAUSE perinephritic abscess may symptomatically simulate intra abdominal, orthopedic, neurologic, respiratory, or lower urinary tract disease, the lesion is not only of general surgical interest but merits medical consideration as well. Frequently clinical evidence of perirenal involvement is lacking. The herewith reported study of 83 cases of perinephritic abscess admitted to the urological, surgical, and medical wards of Bellevue Hospital during the past 20 years seems of particular interest since there is pointed out statistically the possible confusion of symptoms, the diagnostic difficulties encountered, the character and high incidence of complications, and finally that in a third of the cases autopsy disclosed this lesion (unsuspected during life) either as the direct cause of death or as a fatal complicating disease.

## ETIOLOGY

Perinephritic abscess is predominantly a disease of males. Sixty-seven of our cases were of this sex whereas but 16 were women. The only explanation I know of is the greater male incidence of cutaneous wounds due to occupational trauma.

Right and left sided involvement is about equal. We found the abscess on the left side 41 times on the right 40 and bilaterally twice. While abscess extension from one side to the other may occur, bilateral involvement usually means a blood stream infection with bilateral cortical abscess formation.

Age is not a great factor although nearly half of our patients were between the ages of 20 and 40 years (Table I). The youngest, a female of 13 days is of special note in that 7 days after delivery a staphylococcus thumb infection developed, was incised, and septic death occurred 6 days later. Autopsy revealed bilateral, multiple cortical abscesses with an early perinephritic abscess of one side.

Etiologically perirenal abscess may best be classified according to its intrarenal or extra-

renal origin. The former includes all types of infection often associated with trauma, stone, or tumor and nearly always gives clinical evidence of urinary tract involvement. Ureter or kidney perforation by catheter is, for example, an intra urinary tract trauma, I know of 2 such cases. One patient fell, traumatized the kidney, developed an extensive perirenal hematoma which, infected, became a clinical perirenal abscess. In another instance (4), the infection spread through a ruptured diverticulum of the upper ureter (Fig. 1).

Perirenal abscess of extrarenal origin is notoriously free of urinary findings or symptoms. In the absence of renal infection, one must assume the arrival of bacteria in most cases either through the retroperitoneal lymphatic channels or through the blood stream from some distant focus. We know that in some instances the abscess occurs as an extension of a pelvic extravasation, appendiceal abscess, postpartum infection, or from penetrating trauma (gunshot). Infection may also ascend through the lymphatics from the bladder, seminal vesicles, prostate, fallopian tubes, perirectal or other pelvic tissues. Recently I saw a woman 46 years of age with an enormous (10 ounces) staphylococcus retroperitoneal fat abscess, the kidney on this side was removed 4 years ago. Loins pain, fever, and signs of abscess developed 3 weeks following an illness diagnosed influenza.

Clinico-pathological studies, however, decidedly indicate the renal origin (especially cortical or subcapsular) of most perinephritic abscesses. Anatomically the renal parenchymal infection whether originating in the kidney pelvis or whether blood borne from some distant focus to the renal end arteries extends to the cortex, a subcapsular abscess forms, ruptures, and perirenal fat suppuration ensues. While most of these abscesses will eventually become clinically manifest, observation in a recent autopsy case at Bellevue indicates that the disease may become local



Fig. 1 Pyelogram in Stevens case of perinephritic abscess secondary to rupture of ureteral diverticulum. Extravasation of the pyelographic medium into the perirenal abscess mass is noteworthy.

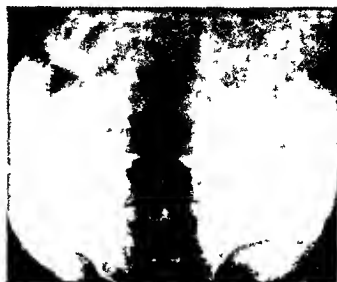


Fig. 2 Obliteration of the psoas muscle outline with spinal curvature away from the perirenal abscess.

ized and heal by encapsulation. In this patient, a male of 44 years, dead of bile-duct carcinoma, the upper pole of the left kidney showed scarring with an attached perinephritic abscess 2 centimeters in diameter enclosed in a calcified fibrotic wall. I have not found record of a similar case. A far more common method of healing is that of extensive perirenal sclerosis. Due to this sclerosis, marked renal and ureteral compression or distortion with the production of symptoms frequently occurs.

An understanding of the perirenal anatomy is important. The perirenal fat is enveloped by a prerenal and retrorenal fascial layer united above but open below and here continuous with the loose tissues of the true pelvis. In this infrarenal portion one finds both perirenal and peri-ureteral fat. Laterally the envelope is closed but medially the layers pass over the great vessels and may or may not fuse with those of the opposite side. Surrounding this fascial sheath is another layer of fat—the pararenal fat—thickest

posteriorly where it overlies directly the large lumbar muscles. Well supplied like the perirenal fat with lymphatics and terminal blood vessels, metastatic abscess formation may also occur here and be clinically indistinguishable from true perirenal abscess.

A perinephritic abscess which has penetrated the posterior fascial layer enters the pararenal fat, usually extends upward, and frequently leads to subphrenic abscess as in 12 of our cases. This latter process may, as I have seen in a case of perirenal abscess secondary to stone pyonephrosis, perforate the diaphragm and cause suppurative pleurisy and terminal pneumonia. While perinephritic abscesses rarely rupture externally, in 2 of our patients this did occur, if neglected, a chronic sinus may result. The fistulous opening is sometimes quite distant from the abscess site.

TABLE I—AGES

Years	Cases
Under 5	2
5 to 9	2
10 to 19	11
20 to 29	24
30 to 39	14
40 to 49	13
50 to 59	10
60 to 70	5
Over 70	2
	83

Youngest 13 days, oldest 74 years





Fig 3. Perinephritic abscess in boy of 7 years. A slight spinal curvature is seen. More striking is the lateral displacement of the kidney as indicated by the course of the ureter catheter. Pyelography confirmed this.



Fig 4. Perirenal extravasation of pyelographic media in case of perirenal abscess secondary to pelvic rupture. The renal pelvis was firmly occluded by a stone.

Staphylococci are the invading organisms in fully 80 per cent of all cases and are metastatic from a distant suppurative process. Next in order of frequency are streptococci and colon bacilli, although pneumococci and gonococci are at times the etiological agent (Table II). Metastatic perirenal abscess may develop during the course of an acute infectious disease more particularly in pneumonia, meningitis, influenza, variola, scarlatina, or typhoid. The most common suppurative foci are infected skin lesions (eczema, wounds, cellulitis, furuncles, carbuncles, paronychia), osteomyelitis, respiratory infections (nasopharyngitis, tonsillitis, otitis media), gastro-intestinal lesions especially appendicitis, and less commonly infections of the genital tract, the prostate in particular. One case was unusual, the patient, a drug addict, developed a staphylococcus perirenal abscess secondary to a hypodermic abscess. In about half of all cases the primary focus cannot be determined (Table III). Bilateral embolic infection is rare, we

found but two instances (2.5 per cent). In one of these, a suppurative appendicitis was the primary focus.

#### PATHOLOGY

Perinephritic abscess may be present as a small localized lesion or may extensively surround the kidney and even invade distant areas, for example subphrenic, pelvic, or scrotal cavities. Thoracic or peritoneal extension sometimes occurs. In one of our cases the abscess burrowed down to surround the rectum. A primary axillary staphylococcus abscess indicated that the perirectal involvement was secondary rather than primary.

If the abscess is of extrarenal origin, the kidney may show only compression. Most often however, the disease is of intrarenal genesis, the involved kidney then may show localized, diffuse cortical, or universal parenchymal suppuration, subcapsular abscesses, renal carbuncle, or there may be evidence of long standing disease—stone, tumor, pyonephrosis, hydronephrosis, pyelonephritis. The

TABLE II — ORGANISMS FOUND IN PERIRENAL PUS

Staphylococcus aureus	34
Staphylococcus albus	1
Bacillus coli	5
Streptococcus	3
Pneumococcus	1
No examination	39

TABLE III — FOCI OF INFECTION

Skin	8
Extremities	1
Middle ear	3
Neck	9
Upper respiratory	9
Genito urinary tract	
Prostate	9
Kidney stone	4
Old kidney infection	2
Ureter suppuration	1
Suppurative endometritis	1
Gastro intestinal tract	
Appendix	3
Colon	1
Diabetes	3
Unknown	30

primary location of the abscess is often hard to determine, the lower and upper renal poles seem to be involved with equal frequency. While most abscesses will be found on the posterior renal surface, unless one inspects the anterior surface well some lesions will be overlooked. Localized anterior abscesses are not uncommon and because they immediately underlie the posterior peritoneum are especially apt to simulate symptomatically acute intra-abdominal disease (Table IV).

## SYMPTOMS

An acute onset in an otherwise healthy individual is the rule. Fever, pain, gastrointestinal disturbances, and urinary frequency are the more common complaints (Table V). Fever is probably present in every case, although it is interesting to observe the slight temperature rise (4 to 6 degrees F) in some cases having gross abscess formation. Fever is most often preceded by chills and if the infection is severe the chills may be followed by drenching devitalizing sweats.

Pain was totally absent in but 6 of our cases. As a rule it is localized in the loin and more particularly the costo-vertebral angle. It may radiate or be referred. Referred pain in perirenal abscess is particularly interesting

TABLE IV — LOCATION OF ABSCESS

Cases	About kidney	Cases
34	Upper pole	30
1	Subdiaphragmatic	3
5	Lower pole	12
3	Retrorenal	9
1	Extending to pelvis	8
39	Associated empyema	6
	Kidney involvement	1
	Cortical abscess	7
	Multiple diffuse abscess	8
		83
	None or not recorded	68

TABLE V — SYMPTOMS

Cases	Pain	Cases
64	Loin	64
8	Abdominal	8
7	Leg	7
6	Respiratory	6
5	Chest	5
3	Hip	3
2	Testicle	2
7	Cough	7
1	Dyspnea	1
4	Difficult breathing	4
6	Acute gastro intestinal upset	6
	Duration of symptoms	
	Less than 24 hours	3
	24 to 48 hours	2
	3 to 7 days	13
	8 to 14 days	17
	15 to 21 days	18
	22 to 28 days	6
	Over 4 weeks	16
	Not recorded	8
		83

Shortest 6 hours, longest 7 weeks

from the orthopedic standpoint. In 3 of our patients, the pain localized in the hip and twice hip joint disease was diagnosed by an orthopedist. It should be noted that not infrequently in children perirenal abscess overlying the psoas muscle will cause hip flexion, excruciating pain in the hip joint region, and commonly leads to the diagnosis of hip-joint disease. In one of our patients, the only symptom was an intense pain in the right knee, by a fortunate delay during which time the correct diagnosis of perirenal abscess was established, anticipated knee exploration was averted. Because of the symptoms produced, perirenal abscess is sometimes incorrectly diagnosed spinal tuberculosis or psoas abscess.

Twice the chief complaint was intense pain in the isolateral testicle. This is obviously spermatic reference and is a phase of the same process giving rise to ureteral or renal colic as a symptom of perirenal abscess. Colic was

TABLE VI—SYMPTOMS AND PHYSICAL EXAMINATION

	Slight	Marked	Total positive	None	Not recorded
Nausea			49	29	14
Vomiting	30	6	36	31	16
Dysuria			18	38	27
Frequency	5	34	39	21	23
Hematuria	1	9	10	57	16
Pyuria (gross)			12	25	56
Rigidity	6	52	58	19	6
Mass felt	34	25	59	6	17
Urinalysis					
Albumin	36	8	44	33	6
Sugar			6		
White blood cells	37	21	63	20	5

a symptom in but one case. Another patient's only pain was in the urethra on voiding, no lower tract disease was demonstrable.

While most patients describe the local loin pain as sharp and stabbing, in some it is only a dull ache. Both types of pain are aggravated by motion. This is readily understood when we remember that spasm and rigidity of the psoas and erector spinae muscles is produced by the overlying inflammatory abscess mass. A lordosis with the convexity toward the abscess not infrequently accompanies the spinal rigidity, and when demonstrated roentgenographically is of diagnostic aid.

In 10 per cent of our patients the pain was entirely abdominal and so strongly indicated laparotomy that normal appendices were twice removed and twice perinephritic abscess was discovered through the opened abdomen. When high right abdominal pain is present, cholecystitis is sometimes incorrectly diagnosed as in one of our cases. Conversely in one patient (not included in this series) in whom the diagnosis of perirenal abscess seemed undisputable the disease was proved to be acute cholecystitis and hepatitis; cholecystotomy cured.

Respiratory pain or difficulty most often bespeaks a complicating subphrenic abscess and may be so distressing as completely to overshadow loin signs. Cough due to phrenic irritation was present in 7 of our patients and is a symptom seldom mentioned in this conjunction.

In 6 instances an acute gastro-enteritis with nausea, vomiting, and diarrhoea heralded the onset. In such event, the extreme physical depletion resulting therefrom seriously handi-

TABLE VII—DIAGNOSTIC PROCEDURES

## Cystoscopy and ureteral catheterization

Of diagnostic help  
Of no diagnostic help  
Confused the diagnosis  
Total cystoscopies

X-ray examination  
Of diagnostic help  
Of no diagnostic help  
Patients examined

## Leucocyte count\*

Under 10 000  
10 000 to 15 000  
15 001 to 20 000  
20 001 to 25 000  
Over 25 000

Lowest 5 500 highest 35 500  
Polymorphonuclear count

per cent  
Under 75  
75 to 80  
80 to 90  
Over 90

\*Only highest count recorded.

caps and rarely may prevent ultimate recovery. In one case this type of onset led the diagnosis of food poisoning, in another that of typhoid fever.

Symptoms of lower urinary tract disease may help to confuse the clinical picture of a diagnosis. Nearly half of our patients complained of urinary frequency. A quarter them reported no frequency, in the remainder this symptom was not recorded. As a rule frequency is painless and is reflex from the upper tract inflammatory involvement. Only 18 cases was dysuria reported as a symptom. Pyuria was noted by 12 patients and hematuria by 10. The pus and blood in the urine usually originate in the inflamed kidney (Table VI).

In some instances the symptoms so closely simulate those of neurologic disease that differential diagnosis becomes unusually difficult. Meningitis and encephalitis were diagnosed in 2 cases each, so striking was the clinical similarity.

The long duration of marked symptoms perirenal abscess in many of our cases is indeed a complementary commentary on the human defensive mechanism. In 4 of our patients, symptoms had been present over 4 weeks, in one instance for 7 weeks. O-

TABLE VIII — BLOOD CHEMISTRY

	Cases
Non protein nitrogen	
Under 30 mgm /100 c cm	10
30 to 50 mgm	19
Over 50 mgm	3
Creatinin	
Under 1.5 mgm /100 c cm	16
1.5 to 2.5 mgm	16
2.6 to 4 mgm	2
Over 4 mgm	3
Blood cultures	
Staphylococcus aureus	6
Streptococcus haemolyticus	2
Bacillus coli (spleen)	1
Negative	11
Total cases	20

TABLE IX — COMPLICATIONS

	Cases
Pulmonary	
Pneumonia	8
Empyema	3
Pleural effusion	1
Embolus	1
Cardiac	
Pericarditis	3
Acute endocarditis	1
Genito urinary	
Suppurative prostatitis	5
Prostatic abscess	2
Acute epididymitis	2
Suppurative seminal vesiculitis	2
Suppurative ureteritis	2
Ureteral stricture	1
Thrombosis of kidney	1
Uraemia	4
Abdomen	
Peritonitis	3
Pelvic cellulitis	2
Pertussis	1
Sepsis	11
Metastatic abscess	
Sternum	2
Scapula	1
Liver	3
Ribs	1
Lungs	6
Cutaneous lymphangitis	1
Repoeking of pus	1
Otitis media	1
Paralytic ileus	1

patient was seen 6 hours following acute onset. In over half, symptoms existed from 3 days to 3 weeks (Table V).

#### DIAGNOSIS

There are, indeed, few lesions in which the diagnosis may be more difficult than in perirenal abscess. The following is a resume of the various diagnoses made in those cases in which the physical findings were not specifically those of perirenal abscess: encephalitis, typhoid fever, meningitis, pulmonary tuberculosis, bronchitis, intercostal neuralgia, endocarditis, cholecystitis, hypernephroma, echinococcus cyst, tuberculosis of the lumbar spine, tuberculosis of the sacro iliac joint, psoas abscess, hip-joint disease, surgical disease of the knee and, in several instances, malaria and influenza. In some of these patients the correct diagnosis was ultimately established during life, in others at autopsy.

Abdominal rigidity was found in 58 of our patients and in 59 a definite mass was palpated. Frequently the rigidity is localized to the muscles of the loin only, but in some instances the entire abdominal musculature of the affected side is splinted by spasm. Rebound tenderness is seldom elicited. Frequently rigidity will be localized only in the costo-vertebral angle and along the erector spinae muscles producing a "poker back."

Tumefaction is found in at least 75 per cent of all cases and when present is an invaluable diagnostic finding. A low loin mass may simulate retrocecal appendiceal abscess or even psoas abscess. The history and urological examination will usually establish by elimina-

tion the perirenal nature of the suppuration.

Laboratory investigations are sometimes of considerable help, especially when urinalysis reveals infection or the blood count shows leucocytosis. It should be remembered, however, that the discovery of a urinary infection does not necessarily establish renal infection as primary to the perirenal process, it may be a secondary development. Pyuria was demonstrated in three-fourths of our patients, albuminuria in half, and 6 were proved diabetics. This latter point is of considerable importance since in 3 diabetics the perinephritic abscess was only one of a number of systemic staphylococcus abscesses.

Leucocytosis is seldom lacking. In half of the cases in which leucocyte counts were made (68) the white cell count was between 15,000 and 25,000, the highest was 38,500. In one fatal case, a leucopenia of 5,500 cells with 65 per cent polymorphonuclears was found, this was one of 5 patients with a total white cell count of less than 10,000 (Table VII).

As shown in Table VIII blood chemistry rarely disclosed marked nitrogenous retention. Unless the opposite kidney is seriously im-

paired, or absent, nitrogen excretion will usually be satisfactorily carried on. Two cases emphasize this, one patient, previously nephrectomized, developed an extensive perirenal abscess of the remaining kidney. The other patient had an infantile kidney on the good side. Both died of uræmia with high blood nitrogen.

Blood cultures showed a systemic infection in 9 of 20 cases thus examined (Table VIII). As one would expect, staphylococci were most often found (6).

Roentgenography may be of great value in establishing the diagnosis. First mentioned by Alexander and described subsequently, simultaneously, and independently by Beer and Lipsett, the frequent disappearance of the psoas muscle shadow on the involved side together with lordosis away from the inflammation is an important diagnostic sign (Fig. 2). On the Urological Service at Bellevue Hospital these criteria have been employed for the past 10 years that I know of. Diagnostically, lumbar lordosis is the more valuable of the two signs since other lesions than perirenal abscess may cause psoas muscle outline obliteration. Lordosis, however, appears later than psoas obliteration. It is due to erector spine and psoas spasm of the involved side. In half (12) of the 46 cases in this series subjected to X-ray examination, the procedure was diagnostically unproductive (Table VII).

Roentgenography is of further valuable assistance in the demonstration of complicating secondary subphrenic abscess. While definite physical signs of this condition are usually present, in certain instances, the roentgen film may first indicate the correct diagnosis. Elevation of the diaphragm with partial or complete obliteration of the costophrenic sinus are the skiagraphic diagnostic criteria. On fluoroscopy limitation of phrenic excursions or actual diaphragmatic immobilization may be visualized.

Cystoscopy with ureteral catheterization, renal function tests, and pyelography may be resorted to when the diagnosis is obscured, but in the anticipation of this procedure it should be borne in mind that perhaps no help will be obtained. Renal infection or diminished function may be demonstrated, pye-

lography may reveal a kidney or ureter displaced (Fig. 3) or compressed by the perirenal mass or may show evidence of the probable intrarenal origin of the abscess (pyonephrosis, stone, tumor, trauma, pyelonephritis). However, in only 14 of the 33 cases in this series subjected to complete urological examination was diagnostic help thereby obtained and what is perhaps more important, in 2 cases the examination findings actually confused the diagnosis (Table VII). The renal pathology was demonstrated on the side without perirenal involvement. Therefore, in some instances lacking a clear diagnosis, loin exploration must be resorted to. Loin exploration with an aspirating needle may be performed but is an unreliable guide. Surgical incision is preferable.

The 26 cases of this series which came to autopsy with undiagnosed perirenal abscess form a most instructive group demonstrating the difficulty of correct diagnosis when symptoms are few or indistinct or when the local signs are overshadowed by those of another grave local or systemic disease. Six of these patients came to autopsy from the medical wards where they had been treated from 4 days to 4 weeks for acute gastro enteritis (2), diabetes (2), influenza, and chronic myocarditis. The autopsy findings are of note.

One patient in whom the predominant symptoms had been those of acute gastro enteritis (diagnosed food poisoning) showed besides the extensive perirenal suppuration, a subphrenic abscess which had penetrated the diaphragm and caused terminal pneumonia with empyema. The other, a tabetic with clinical gastro enteritis, had a secondary peritonitis and empyema due to perirenal abscess extension. Both diabetics died with high fever and sepsis, the perirenal suppuration was unsuspected. Shortness of breath and general toxæmia were the chief symptoms of the "influenza" patient, autopsy disclosed an unrecognized acute suppurative appendicitis as the primary disease leading to extensive perirenal abscess. It is noteworthy in this connection that in a great many cases the toxic systemic symptoms due to the perirenal pus cause the diagnosis of influenza to be made. Finally, the patient treated for

myocarditis with cedema showed a moderate left pyonephrosis due to stone with a massive secondary perirenal abscess. The remainder of the autopsy cases were from other services in the hospital and included two from the Urological Department. In one, the unrecognized perirenal lesion was secondary to prostatic abscess and in the other, to impacted stone pyonephrosis.

The findings noted have been uncritically detailed to emphasize the clinical difficulties encountered in the recognition of perinephritic abscess particularly in extremely ill patients. The diagnostic errors of omission and commission in this entire series of 83 cases were made for the most part by outstanding clinicians of New York City and indicate that in the hands of the less experienced general practitioner, perinephritic abscess will be even less often correctly diagnosed.

#### TREATMENT

Liberal incision and drainage constitutes the treatment of perirenal abscess. Great care must be exercised that all pus pockets are opened, having failed to do this in two cases, re-exploration was necessitated. Suppuration on the interior renal surface in particular should be well drained since secondary intraperitoneal infections from this source sometimes occur. Two-thirds (54) of our cases were operated upon. One patient having a definite clinical and skiagraphic diagnosis of perirenal abscess showed such marked improvement during brief hospitalization that he was discharged without operation. Two others refused operation and in 26 cases the lesion was discovered at autopsy.

Local anesthesia may be used advantageously when the patient is extremely sick and little exploration is required (bulging loin). Often the establishment of a loin drainage hole is sufficient to preserve life and allow a more extensive investigation at a later date. This was done in 4 of our cases. In two instances, spinal anesthesia was used with satisfaction but the majority (48) were given gas oxygen-ether. The initial operation in all was incision with perirenal drainage.

Eleven of the 54 operative patients died, a mortality of 20.4 per cent. Most of these

patients died of complicating lesions or operations other than of perinephritic abscess itself. Thirteen required additional operations, 4 of which were transfusions. Twice secondary perirenal exploration was carried out. In two instances nephrectomy for pyonephrosis was necessary and nephrotomy for drainage was done once. In one case secondary femoral thrombosis required leg amputation and twice complicating abscess demanded prostatotomy.

Without attempting a detailed résumé of the various complications encountered in this series, it should be emphasized that most are pulmonary or urological (Table IX). Pneumonia and empyema are frequently caused by subphrenic suppurative extension. In one case thrombosis of the renal vessels with massive renal thrombosis quite evidently resulted from perirenal suppuration encircling the pedicle. One patient studied 2 years following incision and drainage for abscess showed a tight ureteral stricture in the region of the previous suppuration. We assume this to be the result of perirenal sclerosis.

Suppurative processes in the genital tract were found in 11 cases (15 per cent of the male patients) and required appropriate treatment. One patient showed a fatal generalized postoperative staphylococcus lymphangitis of the loin and back extending from the scapular spine to the iliac crest. Another suffered non-operative paralytic ileus, a symptom said by some to be a rather frequent complication of perirenal abscess and induced reflexly by retropertoneal irritation. Associated metastatic suppuration was found in 7 of our cases, drainage is the treatment.

#### SUMMARY

A clinical study of 83 cases of perinephritic abscess is reported. Etiologically the disease is of extrarenal or intrarenal origin and in the majority of cases bacterial metastasis is the mechanism. While the predominant symptoms are fever, loin or costovertebral angle pain, leucocytosis and reflex urinary frequency, disease other than perirenal abscess may be suggested both subjectively and objectively. With this confusion of symptoms and oftentimes meager or indefinite clinical findings, the diagnosis is difficult. In a third of

this series, the diagnosis was made only at autopsy

Stereoscopic roentgenography is of special value when it shows obliteration of the psoas muscle margin on the side of the abscess or lateral spinal curvature away from the abscess. Moreover, when complicating subphrenic abscess is present, elevation and fixation of the diaphragmatic dome with costophrenic sinus obliteration is diagnostic. Technical urological examination may be of no aid and as we have twice seen may actually confuse the diagnosis.

The treatment is surgical drainage although rarely a patient recovers without operation. Complications are of frequent incidence and

involve the pulmonary and genito-urinary systems in particular. In our series of 54 cases operated upon for perirenal abscess, 11 died, an operative mortality of 20.4 per cent. It is noteworthy that most of these fatalities were directly due to complications and the surgical treatment thereof rather than to the primary abscess.

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PRIMARY CARCINOMA OF THE FALLOPIAN TUBES<sup>1</sup>

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CARCINOMA of the fallopian tubes is classified as either primary or secondary. Although both conditions have been considered rare and relatively uncommon, even now primary carcinoma is the most common tumor of the fallopian tubes. The purpose of this paper is to show chiefly that (1) there is a gradual increase in the number of cases of primary carcinoma of the fallopian tubes, (2) the inflammatory changes in the fallopian tubes do not deserve the etiological significance attributed to them by many writers, and (3) the proper diagnosis of carcinoma of the fallopian tubes can be arrived at only by macroscopic and microscopic examination. Earlier writers recognized the existence of malignant tumors of the oviduct, but they failed to make a distinction between the primary and secondary growths. Renaud, in 1847, reported a case of a malignant growth of the fallopian tube and described the macroscopic appearance of the growth. The plate of this first case on record indicates that the growth was probably primary in origin. Orthmann, as early as 1888, with his case gave the first reliable description of primary carcinoma in the tubes. The third case of carcinoma of the tubes was reported by Doran, in 1888, the fourth by Kaltenbach, in 1889, the fifth by Routier, in 1893, and the sixth by Tuffier, in 1894.

Among the earliest and most notable authorities on the subject were Sanger and Barth, who gave such complete detailed and comprehensive descriptions of the primary growth that their classification of this lesion has remained standard. They reported a group of 17 cases of primary epitheliomata and several tumors of connective tissues. Additional cases of equal value and merit were published by Osterloh, in 1896, and by Ries, in 1897. Then Duret, in 1899, reviewed 35 cases, of which 29 were epitheliomata, 5 were sarcomata, and 1 was a malignant deciduoma. Quénou and Longuet, in 1901, re-

ported 36 cases, with a pathological description and a review of the opinions in all former reviews of the subject. Peham, in 1903, reviewed 62 cases, in 3 of which the condition was bilateral.

Beginning about 1904 and continuing to the present time, an increasing number of cases has been reported. Doran, in 1904, reviewed 63 cases. Orthmann, in 1906, brought the total up to 84. Then Doran, in 1910, again published 100 cases of primary carcinoma, the greatest number of cases which had been reported, although Anduze-Acher very soon reported 115. Vest, in 1914, reported 132 cases, and Moench and Schaerer, in the same year, added 21, making 153 cases. Wechsler, in 1926, after a thorough review, reported on 196 cases, including 4 of his own with 2 of Liang's, 1 by Callahan, in 1929, along with 9 in this paper, now make a total of 206 cases of primary carcinomata of the fallopian tube. Obviously the recognition of carcinoma of the fallopian tubes has increased along with the improved technique and more comprehensive knowledge of microscopic anatomy of tissues.

Following the recognition and acknowledgment of the comparative frequency of carcinoma of the fallopian tube came various opinions and explanations of its cause. Among the most outstanding theories was that of Doran and Fearn, who were of the opinion that primary carcinoma of the tube developed from malignant degeneration of benign papillomata, frequently found in cases of catarrhal and suppurative inflammation. Sanger and Barth, on the other hand, assumed that primary carcinoma develops from long standing, chronic salpingitis. They contended that a papillomatous intermediary stage was unnecessary. In recent years, however, Eckardt and Friedenheim did not find any evidence of inflammatory changes that might safely be regarded as the cause of malignant transformation. They maintained that the inflammatory changes found might

<sup>1</sup>Abstriment. I thus submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of M. S. in Surgery 1929. Submitted for publication May 24, 1930.



be the result of, rather than the cause of the malignant process, especially in those cases in which the growth had infiltrated as far as the serosa. Then too, Eckardt's argument must be taken into consideration, for he claimed that if inflammation were a predisposing factor, more bilateral carcinomata would be found. After thoroughly searching the literature, only 69 cases of bilateral carcinoma were found in a total of 206 cases. Stolz agreed with Eckardt in his opinion that the chronic inflammatory condition of the tube does not warrant the etiological significance attributed to it by Sanger and Barth. It is possible that inflammation may be a predisposing factor in carcinomatous growth of the tubes, but it is just as possible that carcinoma may develop from non-inflamed tubal mucosa.

The rather universal theory first stated by Horrock, that carcinomata are more common in sterile women has often been refuted. For example, Sanger and Barth found only 50 per cent of sterile women in their series, and Stolz, in a series of 17 cases, found only 6 women that had not borne children. In 206 cases reported, 101 women were found to have borne one child or more. Moreover, 48 of the 206 women were sterile, 45 could not be classified as infertile, 13 had miscarried or aborted, and 1 woman was a virgin. Of the 101 who had borne children, 43 were uniparous. The history of pelvic infection is given in only a few cases, but it was noted that 114 women had conceived. Unilateral or bilateral salpingitis was insufficient to prevent conception or the patients were free from infection. Relative to the 43 women who had only 1 child, infection following delivery was a point of consideration. Among the 58 remaining cases statistics showed that the women had borne 5, 7, 9, and 10 children. Because of the inadequate history of pelvic infection and lack of examination of the husband it was quite impossible to determine the cause of sterility in the 48 cases. Stolz has likewise shown that sterility is not more common in women with carcinoma of the fallopian tube than in women with other pelvic tumors. Quenu is of the opinion that chronic salpingitis is only

a secondary factor in a large proportion of cases, and that every neoplasm with papillary growth on the surface becomes infected sooner or later. From these statistics certainly it cannot rightly be concluded or deducted that carcinoma of the fallopian tubes is usually associated with sterility. Like wise, just as few substantiate von Franqué's theory that tuberculosis is an etiological factor in predisposing to primary carcinoma of the fallopian tube.

In a review of the cases from the files in The Mayo Clinic during the period of 1910 to 1928, I was able to find only 9 cases of primary carcinoma of the fallopian tubes, in a series of approximately 10,000 completely removed tubes. Seven of the carcinomata occurred in one tube only, two were bilateral. In other words, eleven primary carcinomata were found in approximately 10,000 tubes, or an incidence of 0.11 per cent. The carcinomatous growth involved the right tube in 3 cases, and the left tube in 4 cases. In the series of about 10,000 tubes, 81 tubes showed definite signs of carcinomatous growth, 70 of which were considered to be secondary in origin, either by contiguity or metastasis. So far as could be determined, 62 were secondary to carcinoma of the ovary, whereas 8 were secondary to carcinoma of the uterus. Norris reported only 1 primary carcinoma and 8 secondary carcinomata of the tube in more than 2,000 gynecological specimens. He also reported 62 carcinomata of the cervix and 32 malignant lesions of the fundus. Novak, stated that at Johns Hopkins Hospital up to December 31, 1927, they had observed approximately 12,000 tubes, and of this number 5 were found to contain primary carcinoma, an incidence of 0.04 per cent. Such statistics certainly do not indicate that inflammation plays such a significant part in the development of carcinoma of the fallopian tube as has been supposed by some writers.

As regards the age incidence, my review shows that in 189 cases in which the age was given, the condition occurred between the ages of 40 and 50 years in 90 patients (47 per cent). According to Mantel, the oldest patient on record was aged 73 years, the youngest patient so far on record (case 3 of



Fig 1 Transition of normal mucous membrane into malignant tissue showing attachment of a malignant papilloma at the left with invasion of deeper structures of the tube Case 2  $\times 40$



Fig 2 Area of malignant papilloma showing reduplication of cells and increased chromatin content with vacuolization Case 2  $\times 75$

this series) was aged 26 years. The following data are in accord with the observations of Sanger and Barth, both of whom pointed out that the age incidence among patients with carcinoma of the fallopian tubes is greatest about the climacteric. The age of the patient was from 25 to 30 years in 4 cases, 30 to 35 in 6, 35 to 40 in 24 (13 per cent), 40 to 45 in 44 (23 per cent), 45 to 50 in 46 (24 per cent), 50 to 55 in 35 (18 per cent), 55 to 60 in 23 (12 per cent), 60 to 65 in 5, 65 to 70 in 1, and 70 to 75 in 1 case.

Sanger and Barth, in 1895, reviewed a series of 18 cases, and after an exhaustive study published a detailed description of the histological pathology of the primary growth. Their classification is still retained and is regarded as authoritative by most writers. They classified the malignant growths as carcinoma of purely papillary structure, and carcinomata of papillary alveolar structure. Another classification frequently referred to is that of Friedenheim's who classified the growths of the carcinomata of the mucous membrane which include papillary and alveolar types, and carcinomata of the wall of the alveolar type.

#### PAPILLARY TYPE OF CARCINOMA

The histological picture of this type of growth shows a delicate connective stem covered with epithelium in a single layer or more, reduplication of the epithelium being

the rule rather than the exception. Usually both forms, the papillary and papillary alveolar, are found in the same section, especially if the growth has penetrated the wall of the tube. The cells vary in size, shape, and staining properties. In the lumen



Fig 3 Area of right tube showing tubercle with giant cell and alveolar carcinoma with acinous formation, densely staining cells few mitotic figures Case 3  $\times 320$



Fig. 4. Papillary carcinoma of fimbriae of the left tube and carcinoma of the left ovary. Case 6

of the tube, however, the normal cylindric cell is more or less preserved. The cells show large nuclei and increase in the content of chromatin, together with a change in polarity. The connective tissue stroma is usually infiltrated with small round cells. As the growth invades the deeper structures, a zone of reaction occurs which consists of fibrous tissue with small round cells and hyalinization according to the reaction of the tissues and rapidity of the growth, as pointed out by MacCarty in 1925.



Fig. 5. Section from wall of tube showing highly malignant cells arranged in pseudo alveolar formation. Case 6.  $\times 320$

#### PAPILLARY ALVEOLAR FORMS

In papillary alveolar forms, the alveoli and pseudo alveoli may be found in the lumen of the tube from apparent fusion of the many papillary projections. The papillary alveolar constructions, however, are usually found in the deeper structures of the tube. Definite solid columns of cells and also alveoli are found between the muscle fibers and beneath the serosa.

The macroscopic examination of the tubes presents a change in shape and size according to the degree of involvement. They are usually club shaped and have the appearance of chronic pyosalpingitis or hydrosalpingitis covered with numerous adhesions. In some instances carcinomatous nodules often appear beneath the serosa.

Klenhaus pointed out that squamous cell epithelioma of the tube through metaplasia of the cylindric epithelial lining may be present. L'Esperance described a carcinoma of the tube with zones resembling the skin. Barrett, in 1916, found keratinized tumor cells with some epithelial pearls. Case 9 of this series illustrates squamous cell epithelioma involving the fimbriated end of the left tube with metastasis to the right ovarian wall of the cyst. In each case a definite palisading and pearly body formation was found.

When these specimens were excised a gray or grayish yellow, irregular, vascular, and friable mass was usually seen. Sometimes the walls were lined with a flat papillary growth,

and the lumen contained dark fluid. Because of the obscurity of some of these growths, differentiation of the normal and the pathological specimen by inspection and palpation alone was difficult, as is illustrated in Case 9 in this series, in which a small area of squamous cell carcinoma was noted in the fimbriated end of an apparently normal tube.

A total of 8 cases in which tuberculosis and primary carcinoma of the tubes were associated have been reported by von Franqué, Lipschutz, Barrett, L'Esperance, Stuebler, Wechsler, and Callahan, Schiltz and Hellwig. A tuberculoma of one tube and a carcinoma of the other were reported by Montgomery, Stacy and Melson, in 1923, reported a case of adenocarcinoma of the ovary and the tube associated with tuberculosis in which the origin of the lesion was doubtful. Case 3 of this series clearly demonstrated bilateral carcinoma and tuberculous salpingitis. The tubercles with giant cells and tubercles with malignant cells occurred in the same field. Case 8 is an example of papillary carcinoma of the left tube and tuberculosis of the right tube.

#### REPORT OF CASES

**CASE 1.** A woman, aged 44 years, was admitted to The Mayo Clinic June 11, 1914. Menses had begun at the age of 19 and were always irregular and painful. She had never been pregnant. In 1903, a small tumor had been removed from the vagina. Appendectomy had been performed in 1910. Three weeks before admission to the clinic, pain had developed in the right lower quadrant of the abdomen. The pain occurred half an hour after meals, it was not referred, and was relieved by enemas. The patient had lost 9 pounds in the last 3 weeks.

The uterus was enlarged and retroverted. A small fibrous tumor in the left side and a mass in the right fornix were palpated. Urinalysis was negative. The hemoglobin was 89 per cent. The pre operative diagnosis was questionable and exploration was advised.

Total abdominal hysterectomy and bilateral salpingo oophorectomy was performed, June 16. Myoma of the uterus, double pyosalpinx and cystic ovaries were found. The right broad ligament appeared to be malignant.

The pathologist reported that on gross examination the ovaries showed chronic cystic oophoritis, chronic salpingitis of the left tube, and a carcinoma of the right tube involving the outer two thirds. The abdominal ostium was closed. The tube was tortoise shaped with many adhesions. The wall

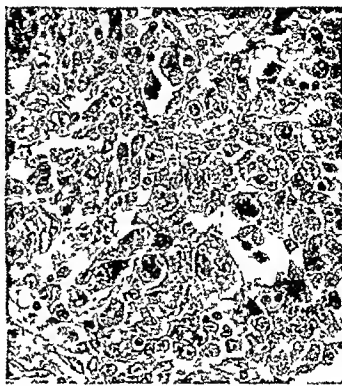


Fig. 6. Section from wall of left tube showing irregular malignant cells with mitotic figures. Case 7.  $\times 320$ .

was thin and was distended with a friable gray mass and purulent fluid. The uterus was enlarged and contained multiple myomata. Microscopic examination, on section through the center of the growth, showed a papillomatous mass that was undergoing necrosis and a few mitotic figures with the growth extending into the muscle and subserosal areas, forming true and false acini of papillary and alveolar carcinoma, graded 2.

**CASE 2.** A woman, aged 51 years, was admitted to the clinic August 5, 1920. She had 4 children, the youngest of which was aged 21 years. Her mother had died of tumor. The patient's menses had been regular and the menopause had occurred at the age of 43 years. Appendectomy had been performed in 1911. May 5, 1920, the patient had had profuse and painless free hemorrhage from the vagina. Bleeding had occurred daily since which had been malodorous for 1 month. The patient had had pain in the lumbar region for 2 weeks before admission to the clinic. She had lost 12 pounds in weight in the last 9 months.

The fundus of the uterus was in the anterior position, the cervix was smooth and not fixed and a slight reddish discharge was observed. Urinalysis showed albumin, graded 2, and erythrocytes graded 4. The hemoglobin was 79 per cent, erythrocytes numbered 5,020,000 and leucocytes 6,400. The pre operative diagnosis was carcinoma of the fundus of the uterus.

Total abdominal hysterectomy, bilateral salpingectomy, and right oophorectomy were performed August 17. The left ovary was missing. The uterus



Fig 7 Two nodules of squamous cell epithelioma at fimbriated end of left tube and two metastatic nodules in wall of right ovarian cyst Case 9

was normal and the tubes were large, adherent and hæmorrhagic. A malignant condition was suspected in the left tube. The right ovary was small and soft. The appendix was removed. The gall bladder was normal but adherent.

The pathologist reported that gross examination of the uterus revealed atresia of the internal os, cystic cervicitis and hæmatosalpinx of the right tube which weighed 62 grams. The left tube was distended with blood stained fluid and the inner surface was covered with papillary growths. The right ovary was atrophic. Microscopic examination, on section near the fimbriae, showed the mucous membrane to be normal, low columnar epithelium could be traced to the origin of malignant papilloma (Figs 1 and 2). The cells were spherical and there were many mitotic figures and definite invasion of the muscular layer beneath the site of the carcinoma, which was of the papillary type, graded 3.

**CASE 3.** A woman aged 26 years was admitted to the clinic October 30, 1913. She had never been pregnant. Dysmenorrhœa and irregular menses had been present for 2 years. Metrorrhagia or menorrhagia was not present. Tonsillectomy had been performed 4 months previously. For 4 months the patient had suffered from generalized abdominal soreness and bloating which had disappeared except for pains in the bladder at night and back ache. For the last 3 days a burning sensation in the epigastrium had been noted. There had been no loss of weight. Examination revealed that the pelvis and cervix were normal. There was a tumor to the left which seemed closely connected with the fundus and which was slightly tender. The pre-operative diagnosis was a fibrous tumor in the uterus. Bilateral salpingectomy, complete oophorectomy

on the left, almost complete oophorectomy on the right and appendectomy were performed November 11. The pelvis was filled with granular material that resembled tuberculous material.

The pathologist reported that on gross section the tubes were tortuous, dilated and bound down together with the ovary, adherent carcinoma of both tubes, chronic cystic oophoritis and chronic catarrhal appendicitis. Microscopic examination on section of both tubes showed areas of malignant cells and tubercles with giant cells in the same field. The right tube contained an alveolar carcinoma, graded 2 (Fig 3); the left tube contained a papillary carcinoma, graded 3.

**CASE 4.** A woman, aged 57 years, was admitted to the clinic May 26, 1921. An aunt had died of carcinoma. The patient's menses had been normal; the menopause had occurred at the age of 40 years. She had never been pregnant. A small tumor had been removed from the vagina in 1904. Profuse metrorrhagia had been present from July, 1920 until a few weeks prior to the patient's entrance to the clinic, at which time a yellow discharge was present which was not associated with pain. The patient had had lumbago 15 years prior to this. She had lost 10 pounds in weight during the previous year. Her temperature was 99.4 degrees F.

The uterus was small, anteverted and movable. Urinalysis and the Wassermann reaction of the blood were negative. Lymphocytes numbered 4,120,000 and the hæmoglobin was 67 per cent. Leucocytes numbered 9,900, polymorphonuclear leucocytes comprised 27 per cent, lymphocytes 35 per cent, eosinophiles, 30 per cent, and basophiles 8 per cent. The pre-operative diagnosis was carcinoma of the fundus of the uterus.

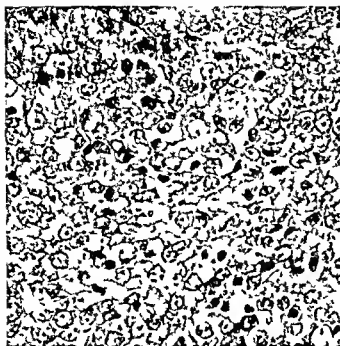


Fig 8 Section of nodule from fimbriae of left tube, showing densely stained cells with many mitotic figures Case 9  $\times 320$



Fig 9 Section of metastatic nodule of wall of right ovarian cyst which shows the same type of cells as in Figure 8 Case 9  $\times 320$

Subtotal hysterectomy and removal of both tubes and ovaries were performed June 2. The left tube measured 8 by 4 by 4 centimeters and appeared to be malignant. The appendix was removed secondarily. The gall bladder contained stones. The uterus contained one fibroma.

The pathologist reported that gross examination revealed a uterus of the infantile type with multiple fibromata, atrophic endometritis, hydrohæmato salpinx of the left tube distended at the fimbriated end with papillary growth, hæmatosalpinx of the right tube, atrophic ovaries, and chronic appendicitis with obliteration of the distal two thirds of the tip. Microscopic examination, on section from the fimbriae, showed malignant papilloma invading the muscle wall. There were spherical cells, prominent nuclei, and many mitotic figures. The diagnosis was papillary carcinoma, graded 3.

CASE 5 A woman, aged 65 years, was admitted to the clinic March 22, 1915. She had had two children. The menstrual history was normal and the menopause had occurred at the age of 50. Cholecystectomy had been performed in the clinic December 6, 1910.

The right kidney was palpable, a pelvic mass extended halfway to the umbilicus. Urinalysis showed a trace of albumin, granular casts, and a few erythrocytes. The hæmoglobin was 82 per cent. The pre operative diagnosis was questionable and exploration was advised.

Supravaginal hysterectomy with removal of both tubes and ovaries was performed April 25, 1915. The right ovary contained a malignant cyst, the size of a pregnant uterus at term. The left ovary and tube were inflammatory. The appendix

was adherent to the tumor. The cyst ruptured during removal.

The pathologist reported that gross examination revealed a uterus of the infantile type, and a right tubo ovarian cyst, an intracystic papillary carcinoma which was attached to the tubal site of the cyst, left chronic salpingitis and left cystic oophoritis. Microscopic examination revealed that the structure of the right tube was replaced by a homogeneous mass composed of spherical densely staining cells which contained many mitotic figures. In the center of the homogeneous mass were several large alveoli lined with large fusiform cells with fascicular nuclei. The carcinoma was of the papillary alveolar type, graded 4.

CASE 6 A woman, aged 52 years, was admitted to the clinic September 21, 1921. She had had 4 children and 1 miscarriage. Her mother had died from cancer of the breast, and a sister had died from cancer of the uterus. The menopause had occurred at the age of 50 years. The patient had been at the clinic in 1916 and had a small mole on the back removed, at which time the pelvis was normal except for a cystocele, graded 2. A sanguineous discharge had been present since July, 1921.

General examination showed enlargement of the thyroid gland. The cervix of the uterus was slightly inflamed, without erosion or induration, the fundus was small and free. Urinalysis of a catheterized specimen showed a trace of albumin and pus graded 5. The hæmoglobin was 72 per cent.

Total abdominal hysterectomy and bilateral salpingo oophorectomy were performed September 23, with removal of a nodule from the cæ-

# CLINICAL SURGERY

FROM THE LAHEY CLINIC

## TWO-STAGE ABDOMINOPERINEAL REMOVAL OF CANCER OF THE RECTUM

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THE plan of procedure to be described has been worked out in this clinic to meet what to us seem certain defects in already existing operative schemes in the two stage abdominoperineal management of cancer of the rectum. The plan is presented with no idea that it should be the sole or is the best plan of two stage management of these serious risk operative cases. The defects of other procedures are presented only as they have appeared to us in our experience, we

fully realize that the inventors of the plans may not agree with us.

As to the originality of the plan, we can only state that we have no knowledge that it has been described elsewhere in the literature or in any of the recent articles on the combined abdominosacral operations for cancer of the rectum. Quite likely this simple plan has already been employed by other men, and an exhaustive search of the French, German, and Italian literature would doubtless reveal this fact. It is not our purpose to make a claim for priority, but to describe and illustrate a method which we hope will prove as useful in the hands of other men as it has in ours.

The steps of our technique may be quite well visualized from Figures 1 to 5. A median incision is made between the pubes and the umbilicus, and the field is investigated for metastases and to determine the operability of the rectal growth. If the growth is operable, the sigmoid is pulled out upon the abdominal wall and the lowest point well above the growth which will reach just above the skin level of the abdominal wall at the pubic end of the abdominal portion of the wound is noted. The mesenteric peritoneum on either side of the mesentery from the sigmoid down to the promontory of the sacrum is cut (Fig. 1), and all the vessels in the mesentery of the sigmoid from the bowel itself down to the superior hemorrhoidal vessels, but not including them are ligated.

Midway between the umbilicus and the left anterior superior spine, a small counter incision is made, through which the permanent colostomy is to emerge. Through this incision, as shown in Figure 2, we pass a long handled Ochsner clamp and grasp the sigmoid or high rectum at the point at which its peritoneum has been cut and the mesenteric vessels ligated. Within the original median incision, another Ochsner clamp is made to grasp the sigmoid just below the first Ochsner clamp, and the bowel between the two is severed with a cautery which also sterilizes both ends of

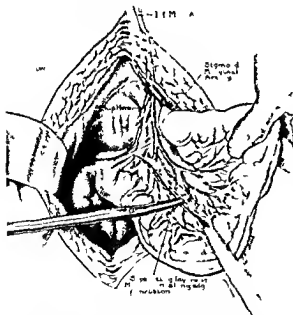


Fig. 1. The median incision, with the sigmoid pulled out onto the left abdominal wall, the mesentery of the sigmoid cut and its vessels ligated from the mesenteric margin of the sigmoid down to but not including the superior hemorrhoidal artery as it descends from over the promontory of the sacrum. The separation of the leaves of mesenteric peritoneum which are later to be sutured together to peritonealize the cut edges of the mesentery is also shown.

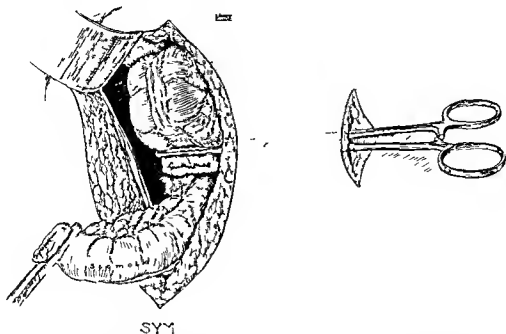


Fig 2 The sigmoid and its mesentery have been divided in the median incision. A clamp is passed through the left counter incision and grasps the upper loop of sigmoid which is to be drawn out through the left counter incision for the permanent colostomy. The clamp in the median incision on the lower segment of sigmoid which is to be implanted in the lower angle of the wound is also shown.

the bowel. The bowel and its mesentery are thus divided down to the promontory of the sacrum, but the superior hæmorrhoidal vessels remain intact and nourish the lower segment of rectum. The two leaves of mesenteric peritoneum on either side of the divided mesentery of the sigmoid are sutured together with continuous fine catgut to cover the raw surfaces to which small bowel might become adherent during the interval between the first and second operative stages (Fig. 3).

The upper Ochsner clamp and with it the upper segment of sigmoid included in its grasp are withdrawn through the proposed colostomy opening. A few stitches are placed in the parietal peritoneum of the colostomy incision about the colon, also a few in the fascia and skin until the wound fits snugly, but without constriction about the end of the colon. No stitches are placed in the colon itself because we have found that these stitches have occasionally penetrated the bowel and have caused leakage and, later, wound infection. The Ochsner clamp is left in place in the dressing and is not removed until the colostomy is to be opened. It seems to us desirable that this loop of colon should not be too short and too direct to the abdominal wall, but that a considerable loop of bowel be left beneath the colostomy to serve as a faecal reservoir (Fig. 4).

As is customary in all colostomies, the mesentery of the upper loop of colon serving as a colos-

tomy is now sutured to the parietal peritoneum of the left iliac fossa to prevent herniation and strangulation of the small bowel about the colon going to the colostomy opening.

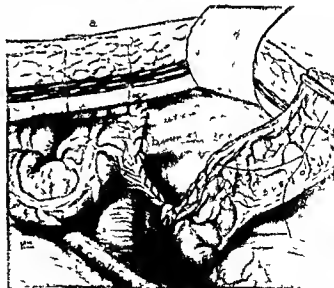


Fig 3 The two leaves of mesenteric peritoneum are sutured over the cut edges of the mesentery. The upper end of bowel has been pulled through the left colostomy incision, *a* (see Fig. 4), and the mesentery of the upper segment of colon going to colostomy opening has been sutured to parietal peritoneum of left iliac fossa, *b* to prevent strangulation of small bowel. The lower segment of bowel being placed in lowest point of median incision where it will remain until the second stage operation.



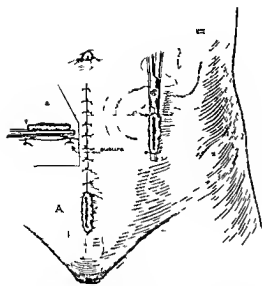


Fig 4

Fig 4 Diagram showing the first stage of the plan we have suggested and employed completed. The end of the lower segment *a* is shown without the Ochsner clamp which remains on it until it drops off. Note the considerable loop of colon which is to serve as a fecal reservoir shown in outline within the abdominal cavity beneath the left colostomy made by the upper segment of sigmoid. The insert *a* shows the plan of approximating skin (and fascia) closely about the end of the transverse colostomy

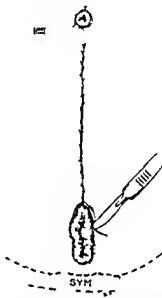


Fig 5

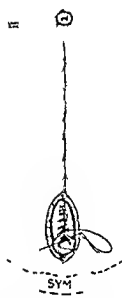


Fig 6

Fig 5 The plan at the second stage of the operation of freeing the end of the lower segment of sigmoid implanted above the pubes at the first stage, as shown in the previous illustration

Fig 6 Closure of the end of the lower segment of the sigmoid (second stage), implanted above the pubes preliminary to reopening the abdomen freeing the pelvic colon and rectum and perineal removal of the freed lower segment in the second stage operation

The lower loop with the Ochsner clamp still on it is placed in the lowest point of the median incision just above the pubes and in contact with it, and the wound is sutured in layers about it and throughout its full extent. The abdominal wound is sealed with a cocoon and if it is necessary the colostomy may be opened within a few days, either by tying a tube into it or by surrounding it with sterile boric acid ointment impregnated gauze, by removing the clamp and permitting the wound to drain into a dressing. If it is anticipated that obstruction will make necessary the early opening of the colostomy, it has proved valuable in our experience to pull a considerable segment of colon through the colostomy incision in the abdominal wall. The procedure permits the tying of a large caliber glass tube into the colon and thus prevents wound contamination for several days. The excess of bowel can later be readily removed with the cautery. The clamp usually cuts through the bowel of the lower segment within a week, at which time the median wound is healed so that it is no longer susceptible to infection.

As soon as the clamp is off the lower segment, irrigations are carried out two or three times daily with a rectal speculum in the anus, so that water

passes freely from the suprapubic opening in the bowel, along the rectum, and out the anus, thus washing out all fecal material and irrigating over any ulcerated and infected area. By this time (7 days) the colostomy is working well, and as much time as necessary can now be taken to get the patient into the best possible condition for the second stage removal, which can usually be undertaken within 2 weeks after this part of the operation.

If further delay is necessary, it can be unhesitatingly accepted, since the bowels move well enough through the colostomy and the lower segment of rectum remains alive and is nourished through the vascularization by the superior hemorrhoidal vessels and is being cleansed by its irrigations. A few days before the second stage is undertaken, the lower segment of rectum is irrigated several times with ST 37 or mercuriochrome, in an attempt partly at least to stenilize it.

At the second stage, the colostomy is sealed with a tight cocoon, and the end of the lower segment of bowel which was implanted in the median wound is separated and sutured with silk or chromic catgut (Figs 5 and 6) in a manner similar to

that described for the suturing of the anus in the perineal removal of the rectum. The stump is painted with iodine. With clean sterile gowns, with a clean kit and clean gloves, the surgeon now reopens the abdomen through the original median incision. An incision in the parietal peritoneum over the superior hæmorrhoidal vessels at the level of the promontory of the sacrum is made and the vessels are tied (Fig 7). Just as in all abdomino-sacral operations for cancer of the rectum, the peritoneum on either side of the rectum and in front of it is incised. The ureters are identified and dissected out. The rectum and its mesentery are freed from the hollow of the sacrum down beyond the tip of the coccyx, its lateral and anterior attachment also is freed, and the bowel is pushed down into the pelvis. The diaphragm of the pelvic peritoneum is restored above the rectum, and in the female reinforced by the fundus of the uterus.

The patient is turned on her side. We wish here to stress particularly that in our experience the lateral position for second-stage removal of the rectum produces much less drop in blood pressure than does the position with the patient turned completely onto the abdomen. In many cases the placing of patients, especially obese ones, face down upon an operating table is a dangerous procedure, because of the serious drop in blood pressure often associated with it. The anus is sutured, as is customary in all perineal removals of the rectum, the wound is painted with iodine, fresh instruments and sterile gowns are provided, and the perineal removal is undertaken in the regular manner, the coccyx being detached or not as seems desirable in the case in hand. After the rectum has been removed, a rubber dam, a cigarette drain, or a gauze pack may be inserted in the pelvic cavity as the case demands, depending upon how well oozing has been controlled.

With this description of our plan of procedure before you, we will discuss some of the disadvantages of other procedures as they have appeared to us.

We have always felt dissatisfied with the two-stage Miles procedure<sup>1</sup> (Fig 8), for the following reasons. If the colon is cut transversely and end colostomy is established either in the upper end of the median wound or in a lateral incision, the colostomy must be established at the time that the pelvic dissection is done. Also in the Miles procedure all of the blood supply of the lower rectum is ligated, and so one has three undesirable factors combined: (1) the production of an unoperated colostomy obstruction, (2) a large pelvic

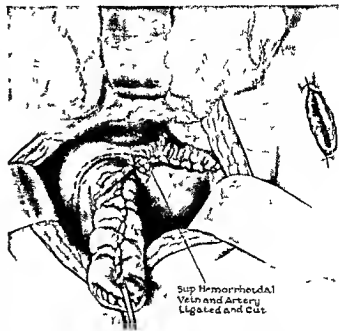


Fig 7 Showing the abdomen reopened at the second stage. The end of the sigmoid which was implanted above the pubis at the first operation shown in Figure 4 has been sutured as in Figure 6. The parietal peritoneum over the superior hæmorrhoidal vessels has been incised and the superior hæmorrhoidal vessels have been cut and ligated. The dotted lines beside the lower segment indicate the incisions in the pelvic peritoneum prior to separating the rectum from the hollow of the sacrum.

dissection with a large area of raw tissue in the pelvis, (3) the placing of a dead segment of bowel filled with infected faecal material in this undrained pelvic pocket, which is covered above by the restored diaphragm of pelvic peritoneum.

Anyone who has done in this manner second-stage removals of unoperated rectums implanted below the pelvic peritoneum recalls with no pleasure the large amount of accumulated foul fluid which gushes out as soon as the coccyx is removed and the pelvic cavity is approached from behind.

In an effort to evolve measures which would prevent them, we have made a study of the conditions encountered after the first stage of the Miles procedure when we have been forced to do the second stage of the operation because patients were becoming distended, often toxic, and in obviously poor condition. The most undesirable features of the Miles operation are the production of an intestinal obstruction (obstruction colostomy) at the same time that a retroperitoneal infection is produced in a large, undrained, open surfaced cavity.

It is these undesirable factors that have led those dealing with cancer of the rectum to incline toward a one stage combined abdominoperineal removal of the rectum when patients could pos-

<sup>1</sup>Miles W. E. Glasgow Med. 1912.

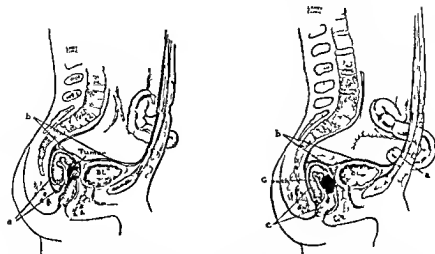


Fig 8 left Drawing showing the first stage of the Miles procedure in which the sigmoid is cut across and an end or transverse colostomy established all of the blood supply to the rectum ligated the rectum dissected from its pelvic attachments the unnourished faecal contaminated rectum *a* pushed down into the pelvis and the pelvic parietal peritoneum *b* sutured over it

Fig 9 The second stage of the combined abdominoperineal operation completed after the preliminary loop colostomy as suggested by W J Mayo Note the undersurable blind stump *c* made by one efferent limb of the loop colostomy when the sigmoid *a* is cut away from it Exclusive of the preliminary loop colostomy, this illustration and plan is the same as the Miles procedure The entire blood supply of the rectum has been ligated and the unvascularized bowel *c* has been dissected from its pelvic attachments pushed into the dissected pelvis and the pelvic parietal peritoneum *b* sutured over it

sibly stand it By this plan the colostomy is produced but the immediate removal of the rectum through the perineum after the abdominal part of the operation is completed, not only does away with the implantation of the dead faeces infected rectum in the closed pelvic pocket, but also permits the establishment of good posterior drainage This one stage plan of procedure is often not practicable, however, because the shock it produces is great and because many of the patients are too debilitated to endure such an extensive operation In addition, the combination of extensive pelvic dissection, the intraperitoneal manipulation in making the colostomy together with the removal of the rectum, and at the same time, the production of an intestinal obstruction by the obstructive colostomy still provide factors well calculated to cause a high mortality

In the course of our study of patients between the first and second stages of the Miles procedure, another disadvantage presented itself in the disproportionate division of time necessary for the two stages, the abdominal part being time consuming and shock producing while the perineal part often took not over 10 or 15 minutes Yet, the very nature of the operation makes necessary the division into abdominal and perineal stages

That the Miles plan is not entirely satisfactory is evidenced by the variety of modifications which have been devised and described from time to time

Appreciating the necessity of having the bowels moving well through an established colostomy and the necessity of avoiding the mortality producing factor of an intestinal obstruction combined with a major intra abdominal operation before the abdominal part of the abdominoperineal removal was undertaken, W J Mayo in 1912<sup>1</sup> proposed the preliminary establishment of a loop colostomy and the delaying of the abdominal portion of the abdominoperineal removal until all obstruction had been overcome and the bowels were moving well

The disadvantages of this plan, shown in Figure 9, are, first, that when the sigmoid is cut away from the efferent loop of the loop colostomy at the second stage removal, a short efferent stub of colon remains attached to the abdominal wall Surgeons who have done this operation have reported to us in personal communications that more than once the sutured end of this stump has opened, leaked, and caused a fatal peritonitis That this is a real menace is shown by Rankin's admonition that when this type of operation is done, the blind

<sup>1</sup>Mayo W J Am Surg 1912 vol 240

stump of colon should be removed. This plan of procedure is similar to the Miles plan and except for the preliminary loop colostomy, has the disadvantages that the abdominal part of the removal of the rectum represents a disproportionate division of the abdominoperineal removal and thus the procedure still possesses the most undesirable factor of the abdominoperineal removal, namely the blood supply to the lower segment of the rectum is ligated and a dead segment of bowel is pushed down into the recently dissected pelvis, which is converted into a tight pocket by the reconstruction of the pelvic peritoneum over it.

Another point hardly a drawback, however, is that the operation thus becomes a three-stage procedure. It overcomes but one undesirable factor, intestinal obstruction, and necessitates the removal of the blind effluent stub of the loop colostomy in a septic field—a procedure not without considerable disadvantage.

Various suggestions have been made to overcome the difficulties mentioned. Rankin<sup>1</sup> has suggested that the colon be cut directly across and that a transverse or end colostomy be established, the cut end of the lower segment of bowel being cut and dropped back into the abdomen as a sutured blind end of the lower segment of rectum and kept there until that segment is to be removed (Fig 10). This procedure has not appealed to us, for it prevents the irrigation of the lower segment of bowel and the cleansing of it of its faecal contents. This procedure is also impracticable if there is any degree of obstruction at the site of the growth in the lower segment of bowel below the sutured end.

Preliminary and permanent cæcostomy has been proposed and practiced by some surgeons as a means of overcoming the obstruction which is occasionally present in these cases and of establishing an abdominal outlet to the faecal content. Cæcostomy as a permanent faecal outlet is undesirable because of the liquid character of the faeces at this point, and because as a preliminary measure it does not permit of complete sidetracking of the faecal stream and of the cleansing of the segment of bowel below its level. Because of the solid character of the faeces at this point and because it provides a faecal reservoir for solid faeces, left sided or central colostomy, preferably in the sigmoid or low descending colon, remains as the best site for a permanent colostomy.

Dahlgren,<sup>2</sup> in 1913, proposed and practiced a plan of preserving the blood supply to the rectum by the following method. The abdomen was

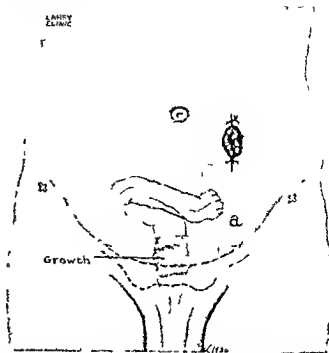


Fig 10 Dr F W Rankin suggests that a transverse or end colostomy be established and the distal end, *a*, of sigmoid sutured over and over and dropped back into the abdomen, to remain as a blind end until the second stage removal.

opened and the vessels to the lower sigmoid and rectum were ligated central to the marginal vascular arch for a distance corresponding to about 25 centimeters of bowel, the blood supply to the lower segment of bowel being maintained through the marginal vascular arch and its anastomosis with the left colic artery (Fig 11). The cæcum was attached to the abdominal wall in the right iliac fossa (Fig 12, inserts A and B), the sigmoid with its centrally ligated vessels was dropped back into the abdomen, and the abdominal wall was closed. On the following day, because of necessity, the cæcum was opened and the cæcostomy was established. Some days later the rectum was dissected free through the perineum and pulled down until the segment of bowel appeared opposite which central ligation of its mesentery had been done, the marginal vessel in the vascular arch was ligated, the bowel cut between clamps, above the growth, and the end sutured, the pelvic peritoneum was sutured to the rectum, the end of which had been closed by sutures, thus making a blind extraperitoneal stump (Fig 12).

There is little in Dahlgren's procedure to recommend itself except the method of maintaining the nourishment of the rectum by central ligation of its vessels, the preservation of its marginal vascular arch, and the anastomosis to the left colic artery.

<sup>1</sup>Rankin F W Surg Gynec & Obst 1929 xlix 193

<sup>1</sup>Dahlgren Karl. Zentralbl f Chir 1913 xl 13 457

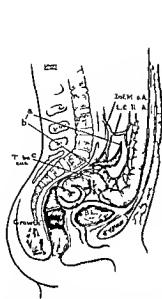


Fig. 11

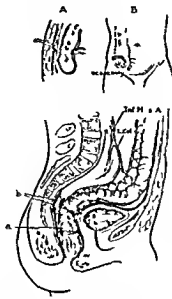


Fig. 12

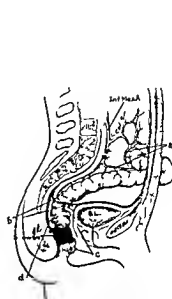


Fig. 13

Fig. 11 The central incision as suggested by Dahlgren in the mesentery of the sigmoid with ligation of the sigmoidal and superior hemorrhoidal vessels the nourishment to the lower rectum being maintained by preservation of the marginal vascular arch. The shaded area *a b* represents the incised mesenteric root. The dotted line *c* represents the level above the rectal growth at which the rectum is to be cut across and pulled down when the lower rectum and growth are removed at the next stage through the perineum.

Fig. 12 The lower rectum and growth have been removed through the perineum. The bowel has been cut across and sutured after the perineal removal so that the point *a* corresponds to the point on the rectum in Figure 11 marked by the dotted line *c*. The pelvic parietal peritoneum *b* has been sutured to the sigmoid to make its blind end extraperitoneal. The inserts A and B showing the circumcisions are included to make clear that fecal

drainage was obtained at this point. This procedure has little to commend it but is of value in that it suggests the retention of viability in the lower segment of rectum by preservation of the marginal vascular arch.

Fig. 13 The first stage of the plan suggested by D. F. Jones the central ligation of the sigmoid and rectal blood supply with preservation of the marginal vascular arch and the establishment of a loop colostomy. This differs from all others in that the rectum is dissected from all of its pelvic attachments at this first stage down to the levators but its blood supply is still maintained through the marginal vascular arch *a* and its communication with the left colic artery and the pelvic parietal peritoneum is sutured to the vascularized pelvic colon well above the level of the growth *b* so that when the second stage perineal removal is made it will be entirely extraperitoneal *c* and the bowel above the growth can be cut across and sutured extraperitoneally at the point *d*.

In 1915, D. F. Jones<sup>1</sup>, of Boston, proposed an operative procedure by which the nourishment of the lower segment of sigmoid and rectum was maintained by central ligation of the vessels in the mesentery of the sigmoid with preservation of the marginal vascular arch—a plan similar to Dahlgren's. Jones' operative plan, however, was different. It consisted in the freeing of the rectum from the hollow of the sacrum, the bladder, or uterus, and from its lateral attachments intra-abdominally, the production of a loop colostomy, and the intra-abdominal attachment of the loosened pelvic parietal peritoneum to the dissected rectum wall above the level of the growth, and above the level of the point across which the rectum was to be later cut across. Below this point the entire rectum was removed in the second stage (Fig. 13). Thus, after the perineal removal

of the rectum and growth, a loop colostomy was left above with a blind efferent end similar to that when the W. J. Mayo plan is used except that the end of the blind loop was long and extraperitoneal in the pelvis. This scheme permitted the establishment of the colostomy and the fecal stream. It permitted irrigation and cleansing of the lower segment of bowel and permitted as much delay as desired between the abdominal and perineal steps of the operation. It further permitted the posterior and perineal steps of the operation to be done extraperitoneally, since the peritoneum of the pelvic floor had been sutured to the tube of rectum above at the anticipated level of transection, thus shutting it off from the peritoneal cavity.

This operation worked very satisfactorily in Dr. Jones' hands and is an excellent procedure. If it has drawbacks they seem to us to be that a blind distal spur of sigmoid must be left, that the suture

<sup>1</sup>Jones D. F. J. Am. M. Ass. 1915 lrv 9

of the lower end of the sigmoid when cut between clamps in the narrow pelvis during the posterior removal must be difficult and sometimes uncertain. There must be some limitation of the amount of sigmoid which can be removed together with its mesentery, since enough mesentery must be preserved to reach below the level of the pelvic peritoneum as far as the distal spur of the loop colostomy.

Two other plans of procedure in the abdominoperineal removal of cancer of the rectum have been proposed by Dr. R. B. Coffey, of Portland. One is the complete ligation of all of the blood supply of the section of the rectum, the introduction of a rectal tube, suture of the ligated distal end of the bowel to this tube, withdrawal of the tube, and telescoping of the rectum on itself until pulled through and out of the anus, where it is held by pins. Since this plan is not applicable to growths which in any way constrict the rectum, it needs but mention as one of the possible plans of procedure.

Dr. Coffey's other plan is similar to that of Miles except that by suture of the lax peritoneum above the pubes in the male, an extraperitoneal tube is constructed about a drainage wick which leads down to the dead segment of bowel within the pelvis and below the sutured diaphragm of pelvic peritoneum. The disadvantages of this

plan are that a dead segment of faeces infected bowel is placed in a raw and completely dissected pelvis at the same time that, as in the other methods, an extensive intra-abdominal operation is done. It has the advantage, however, that drainage is established down to the infected and dead segment, thus overcoming the urgency of removing that segment within a limited number of days.

#### SUMMARY AND CONCLUSIONS

We have employed the operative plan described upon 7 patients with cancer of the rectum. This method is itself not without undesirable features but, as a two stage operation, has so far appeared to offer a nearer approach to the ideal one stage abdominosacral removal of cancer of the rectum than have other procedures.

As much delay and preparation as desired are possible between the first and second stages of the operation.

The duration of the steps is better divided, the greater part being done in the second stage when the patient is in the best state of preparation.

The necessity of implanting dead bowel in the pelvis is overcome.

The second stage involves the removal of a clean, empty rectum.

Good posterior drainage is established immediately after the extensive pelvic dissection.

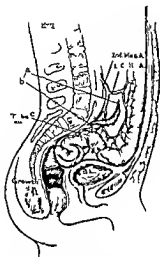


Fig. 11

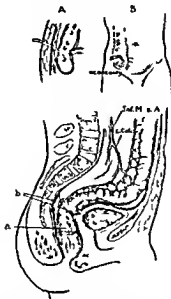


Fig. 12

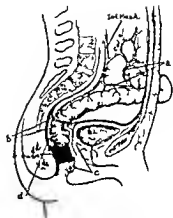


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<sup>1</sup>Jones D F J Am M Ass 1915 Lrv 9



Fig 1 above Schematic drawing of lines of skin and bone section in the preferred amputation for diabetic gangrene of the lower extremities

Fig 2 Right angle muscle section at level of retracted skin

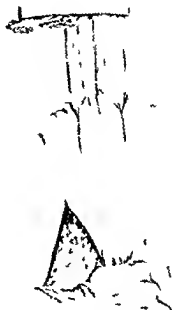


Fig 3 left Appearance of limb after skin and muscle section and method of sawing bone

Fig 4 Closure of the stump by means of figure-of eight sutures



trauma are more imperative than usual surgical principles remain surgical principles Joslin and Foster, Wilder and Duncan, John and Lemann, and others of like knowledge and ability are the men to whom the surgeons owe whatever success they have achieved in this particular field Practically all of my own cases have been prepared for operation under the direction of Dr I I Lemann and he has kindly written for me the following resume of his treatment

"Diabetic patients without infection who are to undergo elective surgery should be brought into the best possible condition by adjustment of their diet and the administration of insulin if necessary Operation should be deferred until the urine is free of sugar and ketone bodies, and until the blood sugar is within or near normal limits, though this latter requirement cannot always be strictly met For at least 2 days before operation the diet should be fairly liberal in carbohydrates, even though insulin must be given to offset them, in order to permit the necessary storage of glycogen in the liver Some hours before operation, usually at midnight an extra feeding of carbohydrates, such as oatmeal or orange juice, is given, and an additional dose of insulin is given if necessary

' On the operating table 20 cubic centimeters of 50 per cent glucose solution is given intravenously, with insulin by hypodermic to insure its

utilization, the amount of the latter depending upon the severity of the diabetes In mild cases, where previous to the administration of glucose there has been no glycosuria, at least 1 unit of insulin is given for every dram of glucose The point of this therapy is to offset the postoperative period of starvation and possible vomiting, though this latter complication is usually absent in patients treated by this method and operated upon under ethylene anaesthesia

"After operation the surgeon is requested to proceed as if the patient were not a diabetic Sweet drinks are given, or glucose by proctoclysis, this diet being offset by the administration of insulin every 4 hours in doses regulated by the intensity of the Benedict reaction in the urine

"The second group of patients comprises those who have infections either essentially dependent upon the diabetes, such as gangrene, or occurring merely as a complication, such as acute appendicitis, and in whom prompt operation is imperative All possible safeguards are employed, though no time must be lost in preliminary preparation Operation is done preferably under local or spinal analgesia, though ethylene may be used where these are impractical Glucose and insulin are administered on the operating table, as has been described, and after operation fluids are forced and the diet is rich in easily available carbohydrate food Insulin is used at regular



intervals. In short, such patients, before and after operation, are treated as if coma were impending."

In all surgical procedures on diabetics, anaesthesia is an important consideration. Ether, generally speaking, is contra indicated. Even in healthy, non diabetic patients it produces a tendency to acidosis and hyperglycemia, dangers which must be doubly guarded against in diabetics, in whom these disabilities already exist. It is true that at the Mayo Clinic ether is used freely, but it must not be forgotten that the percentage employed there, because of the surpassing skill of the staff of anaesthetists, is well below the margin of safety, and that such results cannot be expected generally.

Local analgesia should not be employed unless there are definite contra indications to every other type. Even in healthy persons the percentage of infections with it is two or three times what it is with general anaesthesia,<sup>1</sup> and this percentage is markedly increased in diabetics, whose tissues are notoriously non resistant to the insults of trauma and who develop infection on very slight provocation. Ethylene anaesthesia is most generally satisfactory, as well as safe, and in the cases in which it is contra indicated we have found spinal analgesia by the method of Pitkin equally good, particularly in operations below the umbilicus and on the lower extremities.

To consider specific conditions, the gangrene of diabetes is usually superimposed upon an already existing arteriosclerosis, which, because of hyperglycemia, develops at an earlier age (10 years earlier, according to Eliason), than the usual arteriosclerosis. It may follow infection or be followed by it, and in the former case it is most often precipitated by improper hygiene of the feet, the wearing of ill fitting shoes and hose, the use of radical corn cures, and the cutting of corns and calluses. So frequent, as a matter of fact, is this chain of events that internists realize the importance of warning their diabetic patients of the dangers of these apparently trivial things, though all too often their warnings go unheeded.

Once gangrene has developed, the first link of co operation between the internist and the surgeon must be forged. The surgeon must be called into consultation promptly. He must be given an opportunity to practice his art upon a living, not a moribund patient, to exercise conservatism while conservatism is still a possibility. Emergency amputations upon desperately ill patients are mute evidence that somewhere along the line there has been a lack of co-operation.

Thanks to insulin, diabetic gangrene does not necessarily, in these days, mean immediate amputation, for it is a dry gangrene, which, if the diabetes can be controlled, is sometimes amenable to conservative measures and is sometimes self limiting. That, of course, is a consummation devoutly to be wished, for the patient who lacks a toe is in far better case than the patient who lacks a leg. On the other hand, it must be emphasized that these cases must be selected with meticulous care, that they must be watched unceasingly, and that there must be prompt resort to operation if there is not absolute evidence that the line of demarcation is definitely forming. Diabetic coma is an all too frequent accompaniment of diabetic gangrene, even of the apparently superficial variety, and the conservative surgeon, usually worthy of all praise, adds an appreciable percentage to the mortality of diabetic surgery. Finally, the patient's economic status cannot be ignored. The well to-do patient can afford a long period of disability, the moderately circumstanced or frankly poor patient, with others dependent upon his efforts, cannot so indulge himself, and prompt amputation may serve his interests better than the conservatism which might be desirable otherwise.

Amputation has always been a surgical problem for the reason that it does not always seem possible to reconcile safety, primary healing, and future usefulness. The major premise of the old surgical law of Heidenheim is that amputation should be done above the knee routinely, the reason being that primary healing is more likely to occur in that location because the collateral circulation is more satisfactory there. Against this routine, however, are two arguments: that in all amputations the mortality rises in direct relation to the nearness of the point of amputation to the trunk, and that it is seldom possible to fit an artificial limb satisfactorily above the knee. A pressure bearing stump can be obtained with little difficulty, but leverage to manipulate the leg is lacking. This is a point which cannot be overlooked, for there is more to surgery than merely saving life. Usefulness afterward, particularly in patients in moderate or impoverished circumstances, is almost as important a consideration, particularly in these days when the span of life of diabetics can be prolonged indefinitely by the use of insulin.

For many years past we have in my own clinic steadfastly considered this aspect of the case, and we have arrived at the conclusion that the chief reason for failure of primary healing in amputations below the knee is not a defective blood sup

<sup>1</sup>This point was proved statistically by the author from a study of 457 hernia operations from the records of Toussaint Hospital, New Orleans. The proper evaluation of local anesthesia. New Orleans M. & S. J. 1924. xxvi. 492-495.

ply but a too elaborate technique. We are convinced that beveling, flap formation, and complicated dissection are merely invitations to local gangrene, to infection, and to upward extension of these processes, particularly in diabetics, in whom secondary amputation carries a mortality even higher than the high mortality ordinarily accompanying such a procedure.

It is our custom, therefore, to amputate at the point of election (the junction of the middle and upper third of the leg) by the old amputation of Kocher, the *en sautoir* method of the French writers, which was widely used and adequately tested in the emergency surgery of the War. We believe that this method is logical because the blood vessels of the extremities, in going from tissue plane to tissue plane, do so more or less at right angles, therefore the lines of section are made at right angles to the long axis of the limb, and therefore no tissue is left without its blood supply, there being at least a maximum circulation to the end of the stump.

The procedure is quite simple technically. The skin is incised, then allowed to retract, the muscles are sectioned at the level of the retracted skin, then allowed to retract, finally, the bone is sectioned at the level of the retracted muscles. To express it differently, each time the sectioning is done at a higher level, and the final effect is that of an inverted cone. After careful ligation of the blood vessels—no tourniquet is used, and the ligation is done individually, never *en masse*—the stump is sutured over in two planes, with a minimum amount of tension. Usually only three or four sutures are necessary to bring the tissues over the face of the stump, these being placed in the deep aponeurosis, and the same number are used to guide the skin together. Careful approximation is a minor matter. A figure-of-eight suture may be used with equal advantage, the deep portion of the suture holding the aponeurotic planes together, while the superficial ties guide the skin together. We are extremely careful of our hemostasis, and as a result we do not consider drainage necessary, we believe, too, that while it leads nothing out, it may lead infection in.

The simplicity and swiftness of this procedure are paralleled by its excellent results. I have used it in approximately 60 cases, and the 3 deaths which have followed it all occurred in the pre-insulin days, when surgery was deferred too long and the diabetes was inadequately handled by the starvation method. In all but 2 of the other cases primary union has been the rule. In one of the exceptions drainage was done, many years ago, and infection resulted, the second patient had a



Fig 5 Girdron incision employed in the treatment of carbuncles of the neck. Note that the lines of incision extend into the healthy tissues well beyond the area of inflammatory reaction.

marked infection superimposed on his gangrene, and refused operation for a week after it had been recommended. In both instances re-amputation had to be done above the knee. All of the other patients, however, could be fitted satisfactorily with artificial limbs, and were returned to their homes as potentially useful citizens.

It might be well to add that the indications for amputation and similar details have purposely not been dwelt upon. They are fully and excellently described in the recent text on diabetic surgery written by McKittrick and Root, which is recommended without reservation to those interested in this special subject.

The general surgical principles which have already been stressed are transferred in kind to the management of carbuncles, to which diabetics are peculiarly liable. As in amputation for gangrene, the earlier the treatment is instituted, the better for the patient and the quicker his response to insulin. In my own clinic we have long since abandoned the usual methods of crucial incision and radical excision, because of the long period of disability which follows their use, as well as the great sacrifice of tissue inevitable with them. We have substituted for them the Girdron incision, which is entirely satisfactory in lessening the tension and providing an outlet for the infection, while at the same time healing is more rapid and the hospital stay is markedly decreased. The details of technique need no special description. After the incision there may be rather free hemorrhage, but it is easily controlled by gauze

soaked in 1 per cent carbolic acid solution. No drainage is employed and no packs are used, so subsequent dressings are as painless as possible under the circumstances. In most instances, though the central parts of the central strips are likely to slough, the remaining strips of skin fall into place and act as grafts, and healing is surprisingly rapid.

It is scarcely necessary to point out that strong antiseptic solutions have no place in the skin preparation of diabetics. We have found benzine and iodine followed by iodine entirely satisfactory. We grant the virtues of the acriflavine preparation advocated by Tinker, but the cost is prohibitive for most institutions.

In the surgery of diabetes the principles of absence of trauma, of careful asepsis, and of as great swiftness as is consistent with safety are even more vital than they are in ordinary surgery. We are dealing with patients whose resistance is lowered by a constitutional disease, whose constitutional disease may be aggravated, in spite of the safeguards thrown around it, by the surgical insults which are inevitable in the correction of a surgical disease, whose tissues are notoriously susceptible to infection, and who frequently exhibit in addition to diabetes, other degenerative diseases incident to middle life and advancing

age. Insulin is an ally, but it is not a universal protection against every complication, and its employment should not arouse a false sense of security. The surgery of diabetes is no longer an occasion for timidity and fear, but likewise it is not an invitation to unwisdom, and the success of any surgeon in this disease as in others, will be in exact proportion to the judgment he displays and to the skill, the gentleness and the swiftness with which he does his work.

#### SUMMARY

1 Since the introduction of insulin diabetic patients have become relatively safe surgical risks, provided the pre operative preparation and postoperative care be adequate.

2 An outline is given of the principles of the medical care of surgical diabetics, as practiced in the clinic of Dr I I Lemann.

3 The circular amputation of Kocher is recommended for diabetic gangrene of the lower extremities, and the gridiron incision is recommended for the treatment of carbuncles of the neck.

4 The general surgical principles of absence of trauma, of careful asepsis, and of swiftness consistent with safety, are more vital in the surgery of diabetes than in ordinary surgery.

## A METHOD OF RECONSTRUCTION OF AXILLA FOR CONTRACTURE

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From the Second Surgical Division of the New York Hospital

**I**N the following article is described a method for reconstruction of the axilla, done in stages and consisting essentially of the transplantation of skin flaps from a distance with maintenance of their blood supply through tubed flaps which are in turn utilized in the reconstructive procedure.

Burns involving the axillary folds will often, in the process of healing, produce cicatrices which extend into the subcutaneous tissues and often into the pectoral muscles, binding the arm to the side and preventing abduction at the shoulder. This serious disability may often be avoided if the surgeon adopts preventive measures during the period of healing. These include maintenance of the arm in full abduction following the receipt of the burn or injury, and the application of Thiersch grafts to granulating areas as soon as the appearance and bacteriology of the wounds permit. The more general adoption of the latter principle, stressed by Lyle, will undoubtedly decrease the incidence of contractures following burns of this and other parts of the body.

Unfortunately, patients frequently present themselves with contractures already present, and the problem of replacing the binding scars by normal tissues and restoring form and func-

tion confronts the surgeon. To correct contractures of the axilla, many methods have been described and carried out with varying degrees of success. Probably the simplest of these consists in the division of the contracting scars, forcible abduction of the arm, and the immediate application of Thiersch grafts to the resulting wound. Experience seems to show that this method has little to commend it. The rapid recurrence of the contracture following this procedure may be attributed to the fact that the method does not include excision of the scar tissue, a primary principle in the successful treatment of all contractures.

The most commonly employed treatment makes use of the principle of the shifting of adjoining normal tissues after extensive undermining and following excision of the scar. This may be done in one or more stages. During the period of healing, the arm is maintained in abduction. Many successful results have been reported. This method is hardly applicable where the burns have been extensive and have involved large areas of skin. Its use would not be feasible when there is bilateral axillary contraction. A serious objection to the method is the fact that the skin flaps are usually repaired under con-



Fig 1



Fig 2



Fig 3

Figs 1 and 2. Appearance of patient following the application of Thiersch grafts. Figure 2 indicates the extensive scarring in the axillary folds and the limit of

abduction at this time. Figure 3 is a posterior view of the patient and shows the extent of the burns.



Fig 4



Fig 5



Fig 6

Fig 4 Condition following the first operation. Photograph indicates the position, direction and length of the tubular flaps fashioned on the posterior aspect of the thorax.

Figs 5 and 6 Appearance of wounds following the second operation. It will be noted that a rectangular flap

of skin measuring 2.5 by 6 inches has been lifted away from the underlying fascia on three sides, thus insuring adequate blood supply. This flap remains attached to the chest wall on its fourth side and by the tubed flap. The size of each flap corresponded to the expected deficiency in the axilla following excision of the scar.

siderable tension. Should necrosis take place, the surgeon would be confronted with a more serious problem than the original one.

Within recent years, the use of the free full thickness graft has become more extended. Its field of applicability is gradually being widened. It may be used with success in the treatment of contractures involving other parts of the body,

notably, the popliteal regions, the hand, and the fingers. The writer has had no experience with this type of treatment for contractures of the axilla. A number of theoretical objections to its use here arise. The most important of these is the fact that the resulting wound in the axilla following excision of the scar is of such uneven contour as to lend itself very poorly to the application of firm even pressure which is of paramount importance following this type of skin graft. Then again, it may be stressed that the use of this form of graft is not uniformly successful.

Recently, the writer was confronted with the problem of reconstructing both axillae of a patient



Figs 7 and 8 Condition of patient following the third operation, 2 weeks later. Each rectangular flap has been completely dissected on four sides and swung around by means of the pedicled flap to fit into the deficiency in the axillary region created by the total excision of the scar. The photographs also indicate the method used for compression of the tubed flaps by means of rubber bands.



Figs 9 and 10 The anterior view of patient shows the skin insertions in the axillary folds following the third stage. The posterior view shows the posterior extremities of the original tubed flaps with the method used for elastic compression of the pedicles.

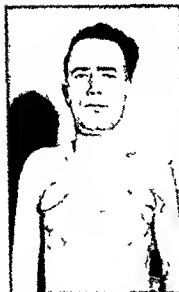


Fig 11



Fig 12



Fig 13



Fig 14

Figs 11 and 12 Appearance of patient following the fourth stage done 2 months later. The pedicles of the original tubular flaps have been divided. Each flap has been turned upon itself after being converted into a flat flap, and inserted into defects in the anterior axillary

regions created by further excision of scar tissue. Figure 12 indicates the limit of abduction following this stage.

Figs 13 and 14 Lateral views of axilla after fourth operation, showing scars on posterior aspect of chest wall and position at this time of original tubular flap.

who had received severe burns involving the entire anterior chest wall. The scarred area was so extensive as to preclude the use of any of the recognized skin shifting operations. The plan finally evolved and carried out, took cognizance of the following principles:

1 Complete excision of all scar tissue which prevented full abduction of the shoulder. This

included excision of cicatricial bands extending into the pectoral muscles.

2 The transplantation of skin flaps from a distance, with maintenance of their blood supply through tubular flaps.

3 The necessity of avoiding vertical suture lines.

4 The replacement of the binding scars by normal pliable skin and subcutaneous tissues.



Fig 15



Fig 16



Fig 17



Fig 18

Figs 15 and 16 Appearance of patient following the fifth and final operation done 3 weeks later. The remains of the original tubular flap have been freed from its distal two thirds and untwisted. A strand of scar tissue running vertically in the axilla (Fig 12) was excised and the remainder of the tubed flap was inserted into this defect so as to run transversely from before backward in the center of the axilla. Figure 15 indicates the normal

contour of the axillary folds. Figure 16 indicates the return of full abduction at the shoulders. It will be noted that the transplanted skin in its final position has the shape of a cross, the long arm of which is the original rectangular flap and the cross piece of which corresponds to the original tubular flap, divided into two segments.

Figs 17 and 18 Lateral views of the chest wall showing the scars which mark the sites of the original skin flaps.



Fig. 19



Fig. 20



Fig. 21

Fig. 19. Posterior view of patient after final operation.  
Fig. 20. Photograph of patient presenting contracture of one axilla following extensive burns.

Fig. 21. Photograph of same patient indicating the extent of abduction.

The history of this case is reported here with in detail and the various stages are indicated in the accompanying photographs.

II C, aged 29 years. The patient received severe burns involving the front of the chest and both upper extremities on June 17, 1928, in a gasoline explosion. He was removed to a hospital in Long Island where his condition was critical for a few days. He was treated at this institution with various dressings until the date of his admission to the New York Hospital, August 18, 1928.

Examination at this time showed an extensive granulating wound over the front of the chest extending from the suprascapular regions to the level of the ensiform cartilage and from one axilla to the other. The skin of both hands and forearms was thin and parchment like. There was considerable impairment of function in all the finger joints while abduction at the shoulders was impaired 95 per cent. The granulating wound on the chest was treated by the Carrel-Dakin method until bacteriological examination revealed sterile cultures. The entire wound was then covered with Thiersch grafts taken from the thighs. Two weeks later the patient was discharged from the hospital with all wounds healed. Figures 1, 2 and 3 indicate the appearance of the scars at this time and the extent of abduction at the shoulders. It will be seen that the contracting scars involved mainly the anterior axillary folds.

He returned in October, 1928, at which time examination showed that all the wounds were healed and that there was marked improvement in motion in the finger, wrist and elbow joints. However, there had been no improvement in shoulder abduction. Because of the bilateral involvement and the extensive scarring in the neighboring tissues a skin shifting operation seemed out of the question. Therefore the following procedure was carried out in stages.

On October 29, 1928, two tubular skin flaps were fashioned on either side of the chest posteriorly near the axilla (Fig. 4). The skin flaps used to form these tubes measured 2 inches transversely and 7 inches longitudinally and were directed downward and outward. Eleven days later, the second stage was performed. On each side of the chest wall and continuous with the distal extremity of each tubed flap, a rectangular flap of skin and subcutaneous tissues measuring 2.5 by 6 inches, was marked out. It was completely dissected away from the underlying fascia on three sides (Figs. 5 and 6). The furthestmost skin attachment was left intact to insure an adequate blood supply. An unfortunate experience with another case emphasized the fact that if this flap is separated on all four sides necrosis of its distal extremity is prone to occur. The size of this flap corresponded to the expected deficiency in the axilla after excision of the scar tissue. The flap was then replaced in its original bed following careful hemostasis, and the skin edges were sutured with interrupted fine silk worm gut. The purpose of this procedure was to permit of the formation of new blood vessels through the tubed flaps before complete severance from the chest wall.

Two weeks later, the third stage was performed. The rectangular flap of skin which had been lifted at the second operation, was separated



Fig. 22



Fig. 23



Fig. 24

Fig. 22. Final result following the use of the operative procedure which has been fully described in the text. Photograph indicates complete abduction at the shoulder joint.

Fig. 23. Anterior view of same patient showing normal axillary fold contour.

Fig. 24. Posterior view of same patient showing the scars on the chest wall marking site of original flaps.

completely from its bed on all four sides, its only attachment to the body being through the original tubular flap. The remaining wound on the chest wall was then repaired by a plastic undermining and shifting of the skin edges. The scar tissue in the anterior axillary folds was then excised. Numerous strands of cicatrix extending into the pectoral muscles were removed. The arm was then widely abducted. This left a defect in the axilla of the same size as the rectangular flap above described. The tubed flap was then swung around below the axilla, and the rectangular skin flap accurately fitted into the defect in the axilla. Fine silk worm sutures were used to approximate the skin edges. Great care was given to hemostasis and the obliteration of dead spaces. The latter was aided by placing fine catgut sutures uniting the subcutaneous tissues of the flap to the wound in the axilla. A similar operation was performed on the opposite side. Pads were applied in both axillae so as to exert firm, even pressure on the skin flaps. At the same time, great care was exercised to prevent any pressure on the tubular flaps. Convalescence

following this extensive operation was uneventful, and the wounds healed by primary union (Figs 7, 8, 9, and 10).

Six weeks later, elastic compression of the pedicles of the tubular flaps was instituted. This was done gradually and extended over a period of 2 weeks, the period of compression by rubber bands being increased daily. Just prior to the fourth operation, rubber band compression was maintained for a period of 24 hours (Figs 7, 8, and 10). This operation was done on February 14, 1929, 2 months after the third stage, and consisted of the following: The posterior ends of the pedicled flaps were divided transversely, and the remaining wounds on the chest wall marking the pedicles were repaired by a plastic undermining of the skin edges. Each tubed flap was then opened along its original suture line over a distance amounting to three quarters of its length. This procedure converted the tube into a flat piece of skin and subcutaneous tissue, measuring 2 inches transversely and 5 inches longitudinally. Each flap was then turned upon itself and drawn forward across the front of the



anterior axillary fold. An area of scar measuring 15 by 3 inches was excised from the anterior axillary fold. Scar tissue extending into the pectoralis major muscle was excised. The flattened tubed flap was then laid into this deficiency and sutured into place with fine silk worm gut. Dead spaces were obliterated. Pressure bandages were applied and the arms were put up in abduction. These wounds healed by first intention (Figs. 11, 12, 13, and 14).

The fifth and final operation was performed 3 weeks later. The pedicles of the skin inserts made at the fourth operation, were divided transversely, thus freeing the remaining third of the original tubular flap. The edge of each scar insert was then sutured to the remainder of the wound in the anterior axillary region after excision of some underlying scar tissue. The remainder of the original tubed flaps was then untwisted and opened along its suture line, thus being converted into flat pieces of skin. A ridge of scar tissue in the center of the axilla marking the suture line of the original skin flap (Fig. 12) was excised leaving a deficiency on the right side extending backward and outward, and on the left side extending backward. These deficiencies corresponded exactly in size to the opened up remains of the tubed flaps. The latter were then

sutured into these defects with fine silk worm gut. The wounds healed by primary union.

Following the last operation, the patient rapidly recovered full function at the shoulders. The final result is indicated in Figures 15, 16, 17, 18, and 19. They portray the complete restoration of function, restoration of normal contour of the axillæ, and a minimum amount of scarring.

A second patient presenting a unilateral involvement, but with extensive scar tissue involving the anterior chest wall, was treated by the same method (Figs. 20 and 21). The end result is indicated in Figures 22, 23, and 24.

#### SUMMARY AND CONCLUSIONS

A method for the correction of contractures of the axillæ is presented. It recognizes the following principles:

1. Excision of all scar tissue.
2. Transplantation of skin flaps from a distance with maintenance of their blood supply through tubular flaps.
3. The necessity of avoiding vertical suture lines.
4. The replacement of the binding scars by normal skin and subcutaneous tissues.
5. The restoration of the contour of the axillary folds.

RESECTION OF THE RENAL PELVIS FOR HYDRONEPHROSIS  
ITS COMPLICATIONS AND RESULTS<sup>1</sup>WALTMAN WALTERS, M.D., F.A.C.S., ROCHESTER, MINNESOTA  
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PIONEER work in the plastic operations on the renal pelvis for hydronephrosis was done by Trendelenburg, Kuster, and Fenger. Kuster, in 1891, reported a method of securing drainage of a hydronephrotic renal pelvis by severing the ureter from its abnormal pelvic attachment and anastomosing it to the dependent portion of the pelvis. He used the method in one case. Fenger, in 1892, stated that he had performed the first successful plastic operation for the formation of valves which produced hydronephrosis. The patient was aged 28 years and had had symptoms of hydronephrosis for 8 years. Bary, in 1896, using Kuster's method, performed the first successful operation of this type in France. This was followed by reports of successful operations by Albarran, Tuffier, and Delbet. Quimby, in 1922, reported 3 cases of hydronephrosis in which he had performed plastic operations, and in 1927, he reported 7 cases in which the ureter had been successfully transplanted to the dependent portion of the renal pelvis. At that time hope was expressed that postoperative tests of renal function and postoperative pyelograms of kidneys that had been operated on, would be made in other cases, to eliminate the possibility of silent renal atrophy. This was done in a series of cases reported by Walters and Braasch. In this paper I shall describe the technique used in these cases and in other successful cases of resection of hydronephrotic renal pelvis and report on certain postoperative complications which have necessitated secondary nephrectomy.

A short review of the causes of ureteropelvic obstruction that produce hydronephrosis may explain the reason for a choice of operative procedures. In my experience, the causes consist for the most part of anomalous blood vessels, usually an artery and vein, which cross and change the angle of ureteropelvic drainage (Fig. 1), with possible interference of ureteral peristalsis by pulsation, as suggested by Quimby. Unless search is made for these vessels as they cross the ureteropelvic junction, they are easily overlooked. With these vessels, it is usually found that angulation of the ureter at the ureteropelvic junction by renal pelvic or perirenal pelvic connective tissue has occurred which, with dilatation of the renal pelvis, produces ureteral compression (Fig. 2). In some

cases the absence of demonstrable obstruction in the presence of large hydronephrotic sacs suggests disturbances of neuromuscular control of the renal pelvis and upper part of the ureter.

## ANOMALOUS VESSELS

If an anomalous vessel is compressing the ureter at the ureteropelvic junction, thus changing its course and interfering with proper emptying of the pelvis, and if the additional blood supply is sufficient, I see no reason why the anomalous vessel should not be divided. I have divided it successfully in several cases, one case was that of a woman with polycystic kidneys, reported elsewhere. If, however, as a result of this type of obstruction, the extrarenal pelvis is considerably dilated, it is resected to within 1.5 centimeters of the renal substance, leaving the ureter attached to its dependent portion. Closure of this opening in the pelvis removes the hydronephrotic sac and changes the course of the ureter, and its opening becomes dependent. In the cases in which this was done, nephropexy was also done to prevent further ureteral angulation. In some cases temporary nephrostomy was done also, to relieve pressure on the suture lines. If for any reason there is a question of inadequate blood supply from the remaining vessels to the kidney, circulation in the anomalous vessels should not be obstructed, particularly if the opposite kidney shows any abnormality of function. Such obstruction existed in one of the cases in which there was a large hydronephrotic sac on both sides. In such cases the dilated extrarenal pelvis is resected, or the ureter is reimplemented into the dependent portion of the pelvis away from the anomalous vessels.

INCULCATION AND COMPRESSION OF THE URETER  
BY PERIPELVIC CONNECTIVE TISSUE

In several cases of hydronephrosis in which nephrectomy was necessary because the kidney was largely destroyed, compression angulation and obstruction of the ureteropelvic junction occurred as a result of a dense sheath of connective tissue. This tissue apparently originates from the tissue of the renal pelvis. Its congenital nature is suggested by postmortem observations in a child aged 17 days, whose death was the result of renal



Fig. 1 Anomalous artery and vein of large size crossing, and obstructing ureter at ureteropelvic junction (arrow points to artery) ureter between artery and vein

insufficiency caused by bilateral hydronephrosis which in turn was due to such a connective tissue sheath. Division of this sheath if the hydronephrotic sac is small combined with resection of the renal pelvis if the sac is large, should be considered provided sufficient renal parenchyma exists. If there is doubt in this respect and if the opposite kidney is normal nephrectomy is the better procedure.

#### ABSENCE OF DEMONSTRABLE OBSTRUCTIVE LESIONS

Hydronephrosis, in the absence of demonstrable obstructive lesions was present in 3 cases. One case in particular is noteworthy. The hydronephrosis was bilateral, each pelvis had a capacity of 150 to 175 cubic centimeters. A large anomalous artery and vein crossing the right ureter at



Fig. 2 Ureter obstructed by peripelvic connective tissue and by an obliterated anomalous renal vessel

the ureteropelvic junction presumably was the cause of the obstruction whereas the left kidney, also hydronephrotic, and with the same capacity, did not show demonstrable obstruction at the pelvic junction. The same operative procedure was carried out on both sides, namely, resection of the renal pelvis. This was followed by equally good results, there was no longer retention in either pelvis.

#### RESECTION OF THE HYDRONEPHROTIC RENAL PELVIS

I used this method of operation in the first case in which there was no demonstrable cause for the obstruction. The dilated portion of the left hydronephrotic pelvis was excised (Fig. 3) and the ureter was severed from the pelvis and reimplanted into its dependent portion (Fig. 4). Anastomosis was made with three rows of chromic catgut and protection of the suture line with a portion of peripelvic fat. On the tenth day after operation, stasis occurred with retention of a small amount of infected urine in the kidney. A ureteral catheter was inserted through the cystoscope for pelvic drainage (Fig. 5), following which satisfactory convalescence occurred. In the succeeding cases,

it seemed advisable to develop a method by which the hydronephrotic portion of the pelvis might be excised without entirely severing the ureter from it, in the hope that pelvic stasis would be prevented. Figure 6A shows the hydronephrotic pelvis being separated from the blood vessels of the renal pedicle. Figure 6C shows the pelvis excised to within 1 centimeter of the renal parenchyma, thus changes the course of the ureter from a lateral insertion to a dependent one. Figure 6D shows the opening of the pelvis closed with chromic catgut in a manner similar to that described.

In the 3 last cases in which operation was performed, temporary nephrostomy has been found to be advantageous in that it removes tension from the anastomosis. An additional ureteral catheter is inserted, extending through the cortex and into the ureter. It serves as a scaffolding and a splint to promote healing without obstruction at the ureteropelvic juncture.

#### REIMPLANTATION OF URETER INTO DEPENDENT PORTION OF THE RENAL PELVIS (KUSTER QUINBY)

Kuster and Quinby believe that removal of the ureter from its lateral attachment to the hydronephrotic renal pelvis and its reinsertion by suture to the dependent portion of the pelvis away from these anomalous vessels is indicated if the anomalous vessels crossing the ureteropelvic juncture are of such size and importance that their division and ligation seem inadvisable. Such a method was used successfully in one case (Figs 7A and B). Inasmuch as the technique for this opera-

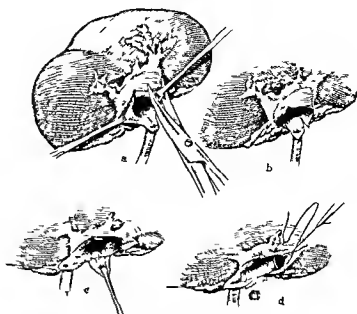


Fig 3 Resection of hydronephrotic renal pelvis

tion has been fully portrayed by them it will not be repeated here.

#### COMPLICATIONS

Anticipated postoperative complications seem to center around (1) leakage of urine at the point of anastomosis with perirenal accumulation, (2) retention of urine in the kidney, leading to pyelonephritis or cortical abscesses in the kidney, and (3) ureteral obstruction at or below the pelvic incision with a persisting urinary fistula from the pelvic anastomosis.

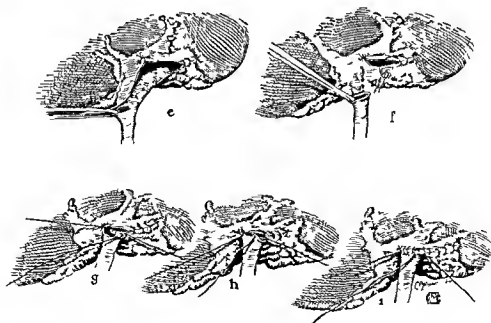


Fig 4 Resection of hydronephrotic renal pelvis, reimplantation of ureter into dependent portion of pelvis

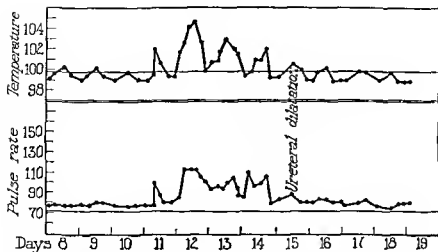


Fig 5 Temperature chart showing effect of urinary accumulation in renal pelvis and its removal

Accumulation of urine about the kidney in one case necessitated reopening of the incision and drainage of the perirenal space. Approximately 700 to 800 cubic centimeters of infected urine was evacuated. A study of the function of this kidney and a pyelogram made 2 weeks later, showed a practically normal kidney from which urine was being excreted in normal quantity and discharged into the bladder through the ureter. The function of this kidney was better than that of the other kidney, the excretion of indigocarmine was graded 2 (Fig 8). When the patient was allowed to return home 2 weeks later, the incision had practically healed and drainage of urine had ceased.

#### RETENTION OF URINE IN THE PELVIS OF THE KIDNEY

In the first case in which operation was performed, retention of urine in the kidney manifested itself by cessation of drainage from the incision, chills and fever, on the tenth day after operation. A ureteral catheter inserted into the pelvis of the kidney withdrew 5 to 10 cubic centimeters of turbid urine. The fever subsided and the patient's recovery, although slow, was satisfactory (Fig 5). This patient has recently begun to have trouble in the opposite kidney, and exploration of this kidney will probably be necessary at some future time. In the case in which the Kuster Quinby technique was used, evidence of retention of the urine in the pelvis again manifested itself by fever. The retention was relieved and reaccumulation was prevented by allowing an indwelling ureteral catheter, which was inserted through the cystoscope, to remain in place.

The catheter was kept open by frequent irrigation. The associated pyelonephritis was completely controlled by intravenous injections of neosalvarsan. This patient's progress subsequent to operation has been excellent, urine is no longer retained in the pelvis of that kidney (Fig 4) and his general condition for more than 7 months has been excellent. In another case in which the general condition did not permit pyelographic study following resection of the renal pelvis, urine was seen to drain from the kidney which had been operated on through the ureter into the bladder on cystoscopic examination. Nevertheless, at times, the patient showed evidence of the presence of pyelonephritis, characterized by chills and fever. Finally, it was necessary to remove the kidney in spite of what appeared to be adequate drainage. Pathological examination of the removed organ showed diffuse pyelonephritis and small cortical abscesses.

#### OCCCLUSION OF THE URETER WITH PERSISTING URINARY FISTULA

In another case it was necessary to remove the kidney secondarily to resection of the hydronephrotic renal pelvis because of a persisting urinary fistula, apparently caused by postoperative perirenal and ureteral infection occluding the latter. At the time of operation, it was noted that the sac was large, containing approximately 350 cubic centimeters of urine, and that the parenchyma of the kidney was half the normal size. The kidney was removed 50 days after the plastic operation, it weighed only 67 grams. The decision to attempt resection of the renal pelvis rather than nephrectomy probably was unwise because of the extreme

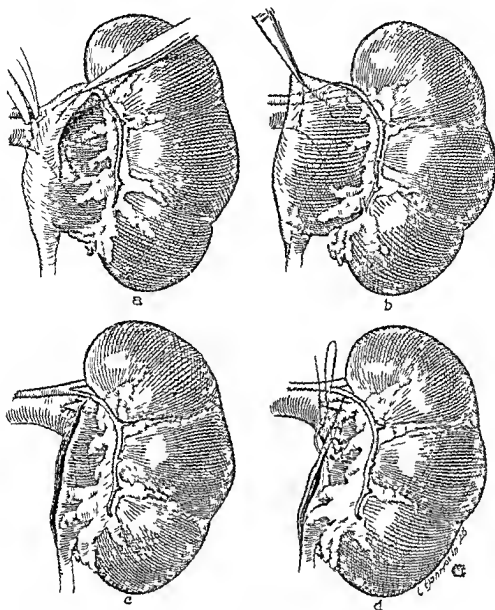


Fig. 6 Resection of hydronephrotic renal pelvis allowing ureter to remain attached

degree of hydronephrosis and the reduction in the size of the renal parenchyma

#### SUMMARY

In 11 cases of hydronephrosis, resection of the renal pelvis was performed. In 8 cases (9 resections) the results of operation were excellent. In 4 of these cases hydronephrosis was bilateral, and the renal pelvis was large and infected. Bilateral resection was done in one case, with an interval of 3 months between operations, with excellent results. Practically 2 years have elapsed since these operations, and the patient has been completely relieved of all symptoms of renal retention or obstruction. This is probably the first successful case in which resection of bilateral infected hydronephrotic kidneys has been reported.

In 3 additional cases of bilateral hydronephrosis successful resection of one hydronephrotic renal pelvis has been performed. Three months will elapse before the other renal pelvis is resected.

Cases of hydronephrosis in which successful results followed division of anomalous blood vessels, or connective tissue sheaths, are not included in this series of pelvic resections.

Three cases in which resection of the renal pelvis was performed required secondary nephrectomy due to (1) persistent urinary fistula from occlusion of the ureter by postoperative infection around the ureter, and (2) pyelonephritis with cortical abscesses in 2 cases in which urine was being transmitted successfully from the resected renal pelvis to the bladder through the ureter. Complete recovery followed nephrectomy.



Fig 7 A Pre-operative pyelogram B postoperative pyelograms Kuster-Quinby method used of reimplantation of ureter into dependent portion of renal pelvis

When postoperative stasis occurred in the renal pelvis it was successfully relieved by the introduction of an indwelling ureteral catheter through the cystoscope, where it was retained as long as the retention persisted. In spite of leakage of urine from the anastomosis with perirenal accumulation, results may be satisfactory provided drainage is sufficient.

#### CONCLUSIONS

1. Resection of the hydronephrotic renal pelvis is an operative procedure worthy of consideration if there is sufficient normal renal parenchyma and if the function and condition of the opposite kidney is not entirely satisfactory.

2. Bilateral resection of bilateral hydronephrotic kidney, as was done in a case in this series, may be followed by excellent results. The postoperative complications, such as temporary accumulation of urine within the renal pelvis immediately subsequent to operation, leakage of urine from the pelvic anastomosis, and pyelonephritis if adequately controlled may not compromise the end result of the operation of renal pelvic resection. Yet, if response does not occur, nephrectomy



Fig 8 Pyelogram following resection of renal pelvis with urinary leakage from anastomosis necessitating drainage

may become necessary and should not be too long delayed provided the opposite kidney is normal.

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## TRANSPLANTATION OF THE HEAD AND SHAFT OF THE FIBULA TO THE HUMERUS

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THE only other case of transplantation of the head and shaft of the fibula to the humerus that I know of is the one reported by P. G. Skillern.<sup>1</sup> In Skillern's case the humerus was removed for sarcoma and the head and shaft of the fibula were used instead of the head and shaft of the humerus.

In the case discussed here we were dealing with non union of a comminuted fracture of the humerus followed by a low grade type of osteomyelitis due no doubt to the various kinds of material used to hold the fracture in place to assist in the union of the two fragments of the humerus. We encountered considerable difficulty in keeping the fragments in apposition. Numerous trials at reduction were made but without success. Many types of splints in addition to plaster casts were used but we could not keep the fractured ends together. It required six open operations before we attained success. The various steps will be given in full as we relate the history of the patient. Briefly we used Parham bands on two occasions, a Sherman plate, a tibial bone graft, and finally the fibular graft. The patient now has a good arm, the flail arm being replaced by a

firm one—which is useful although the range of movement is somewhat reduced as compared with the normal. There is also some radial nerve palsy which is mending slowly.

K. T., aged 50 years was admitted to the Jewish Hospital, February 25 and discharged March 15, 1927. She had slipped on a rug at the top of the stairs and fell, sustaining a fracture of the upper third of the left humerus (Fig. 1). Numerous trials at reduction were made but without success. An open operation was performed March 5. A Parham band was used with the result that the ends were in fairly good position (Fig. 2). No drainage was used. On February 25, the radiologist reported "a comminuted fracture involving about 4 inches of the upper portion of the left humerus and extending almost into the head of the bone."

Patient was again admitted May 24, 1927 and discharged June 21, 1927. No union was present 3 months after the injury. She had no pain but noticed that she could not use her arm. The left hand was partially paralyzed. The old scar was excised, many adhesions were separated and the humerus was exposed. The hand was removed and in its place a Sherman plate was inserted (Fig. 3), and a plaster cast applied with the arm at an angle of 45 degrees. Union did not take place after this operation. It was with great difficulty that we persuaded the patient to submit again to operation.

She was admitted to the hospital the third time on February 28, 1928, and was discharged March 13, 1928. At this time the metal plate was removed and the ends of the bone were still ununited. They were freshened by



Fig. 1

Fig. 1 Retouched roentgenogram of fracture immediately after the accident.

Fig. 2 Parham band in position. Used in first and fourth operations. Retouched photograph.



Fig. 3

Fig. 3 Sherman plate which was used at the second operation and the result after the cast had been removed. Drawn from roentgenographic plate.

<sup>1</sup>Internat. Clin. 1910.





Fig 4

Fig 4. Bone graft from right tibia. The distal portion became firmly united. Non union of upper part of graft. Drawn from X ray film.

Fig 5 illustrates the removal of the head and shaft of the humerus on account of a low grade osteomyelitis



Fig 5

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Fig 6

An interval of 4 months followed before the fibular graft was used.

Fig 6. Showing transplant of head and shaft of fibula to the distal end of the humerus. Drawn from X ray film. A moving picture of this operation was obtained

means of the Albee saw and a bone graft taken from the right tibia was transferred to the arm (Fig 4). The graft was held in position with kangaroo gut. Pathological examination of a section of bone revealed considerable inflammatory tissue surrounding portions of the bone at the periphery with the blood vessels congested and fibrous tissue cystic at points.

After this operation there was union of the fragments but the patient did not agree with me. In a fit of anger she broke the graft near the proximal end of the fracture. This loosened the graft in the proximal end of the bone the graft in the distal portion being firmly united to it. This was the condition of affairs found when she entered the hospital for the fourth time on May 20, 1928. An open operation was again performed the old scar was excised the adhesions were separated around the humerus

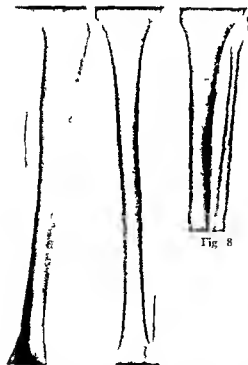


Fig 8

Fig 7

Fig 7. Regeneration of the fibula. One year after operation.

Fig 8. Regeneration of tibia 2 years after Albee bone graft.



Fig 9. The result 1 year after operation.

and the graft was cleared of surrounding tissue. The lower fragment of the broken graft was firmly united, the upper fragment was lifted out of the wound. The ends of the fracture were again freshened. Great difficulty was now encountered with the upper fragment as nothing would hold in the degenerated softened bone. Bone pegs, bone screws and bones were tried but all to no avail. Finally a Parham band was again applied so that the graft in the distal fragment would act as a splint to hold the upper fragment long enough to form callus. But no union occurred. Patient was discharged on June 3, 1928.

She was admitted for the fifth time November 15, 1928 and was discharged November 27, 1928. She complained for the first time of pain in the left arm, and inability to move it. She took the sun treatment all summer believing that this would help her to generate some callus. The old scar was again excised and the humerus exposed. This was found necrotic especially at the ends of the bone. It was also found that the shaft of the humerus attached to the head was necrotic. The portion including the head was excised at the shoulder joint. Pathological report: Specimen consists of the head of the humerus and a small portion of the shaft. The articular surface appears normal. The bone itself appears exceptionally thin. It is partly transparent. The medullary cavity is rough and its contents are exceptionally friable. Section shows the bone undergoing destruction. Here and there are areas of round cell infiltration.

Although all preparations had been made to use another massive tibial graft it was thought advisable to allow the mild inflammatory condition to subside before attempting any kind of bone transplantation. This was concurred in by Dr. C. F. Nassau who was a spectator at the former operation and the next which happened to be the last (Fig. 5).

The patient was admitted the sixth time March 20, 1929, and was discharged April 3, 1929. Patient now complained of a flail arm. The old scar was excised and the arm was prepared for the fibular graft which I decided was the only logical method after the former operations. The distal two thirds of the shaft of the humerus was found to be soft and decalcified. It was necessary to remove the shaft of the humerus to a point about 2 inches above the condyles. The glenoid cavity was cleaned to receive the head of the fibula.

An incision was then made along the lateral side of the left leg over the fibula. A segment of fibula, equivalent in length to the missing portion of humerus was excised and transplanted to the left arm (Fig. 6). The end of the shaft of the fibula was gently tapped into the medullary cavity of the humerus. This made a perfect fit precluding the use of bone pegs or screws. The head of the fibula was snugly secured in the glenoid cavity. A few interrupted sutures of catgut in the deltoid muscle held the head of the bone in place. The arm once more was restored in continuity. A cast was applied with the arm at an angle of 45 degrees. X-ray examination on April 2, 1929 made through the cast revealed a long piece of bone extending from the shoulder joint downward to about 1.5 inches above the elbow joint. This bone appeared to be in excellent alignment with the lower end of the humerus. It is difficult to recognize any callus due to the irregularity of the shadow cast by the plaster.

It is now one year after the last operation which has been eminently successful. The fibula is firmly entrenched in the shaft of the humerus (Fig. 7). The head of the fibula moves freely in the glenoid cavity. The arm can be moved at will in all directions except that the arc of motion is not as great as formerly. This may partly be due to fear of breaking the arm.

INJURIES TO THE SEMILUNAR CARTILAGES OF THE KNEE JOINT<sup>1</sup>

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THE anatomical structure of the knee joint is of a more or less composite character, although chiefly of the hinge type. During action there is a constant change of surface contact for weight bearing between the femur and tibia not seen in true hinge joints, such as the elbow and the ankle. In the final part of extension there is a certain amount of outward rotation of the tibia on the femur and in full flexion a certain amount of inward rotation. This departure from a true hinge like action that has a broad surface contact is probably the chief cause of most of the derangements of the semilunar cartilages.

Injury to the semilunar cartilage is the most common cause of derangements of the knee. The internal and external semilunar cartilages occupy, respectively, the inner and the outer compartments of the knee, resting on the internal and external tuberosities of the tibia. They partially cover the articular surfaces of the tuberosities, and deepen the fossae for the reception of the condyles of the femur, the internal cartilage covers less of the tibial articular surface than does the external. The latter is said to cover, occasionally, the entire surface of the external tuberosity. The two menisci are connected anteriorly by the transverse ligament, and, although the internal meniscus is firmly attached to the internal lateral ligament or capsule, the external cartilage is rather loosely bound to the capsule, but both are quite firmly attached posteriorly to the intercondylar fossa. The coronary ligaments bind the cartilages to the tibial head and are at the periphery, they are intimately associated with the capsule and are of no importance surgically. The inner margins of the cartilages are free, making it possible for small foreign bodies, such as needles, to hide away under the meniscus. A fact not generally realized is that the semilunar cartilages are partly fibrous, and are more prone to rip or tear longitudinally in their substance than they are to fracture transversely, so that the term "torn cartilage" would in most instances be more apt than that of "fractured cartilage."

The internal semilunar cartilage is more frequently injured than the external, owing to the fact that if it is caught between the internal condyle of the femur and the head of the tibia and the act of extension is continued, it cannot slip

out of the vise like hold, because it is firmly anchored at its periphery to the internal lateral ligament. If the force continues, the cartilage generally rips in a longitudinal direction, remaining attached anteriorly and posteriorly, the loop thus formed slipping into the intercondylar notch and producing the typical bucket handle fracture described by Morison. This is the most common type of tear and it is not confined to the internal cartilage. I have reported (7) 2 such tears of the external cartilage encountered in 76 cases of bucket handle fractures. Three other cases have been observed since this report. Fagge recently expressed the opinion, and I am inclined to agree with him, that most of the tears and injuries of the internal cartilage are primarily of this variety, and that further injury converts them into various other types. Basing the classification on observations at operation, I would divide the various injuries to the internal semilunar cartilages into four main types (Fig. 1).

1 A tag like flap of varying size which is split off from the anterior portion and hangs free with its base attached to the posterior mesial portion of the anterior third (Fig. 1a).

2 The same type of pedunculated flap may be seen in the middle third of the cartilage, sometimes doubled back on itself and pointed posteriorly (Fig. 1b). This is a difficult type to see at operation, and one that may readily be missed. Such a flap may be worn into an ear shaped tag attached by a rather small short pedicle. When caught, it causes sharp, severe pain, but is usually released readily if the patient gives a vigorous kick or two, and swelling or disability does not follow. I am confident that many times these ear shaped tags are overlooked at operation because they are rather deeply situated, and not easily seen. In this event, the cause of the attacks is attributed to the more or less mythical fat tags that are removed.

3 The bucket handle or loop type of injury (Fig. 1a), which has been mentioned causes the most constant symptoms, and generally is readily diagnosed.

4 A pedunculated flap, in the posterior third of the cartilage, gives rise often to bizarre symptoms. It is generally impossible to see anything of such a flap in this position, through an anterior incision, and it is not until the cartilage is removed

or a posterolateral incision is made to explore the posterior portion of the cartilage, that the lesion is discovered (Fig 1d)

Apparently, injury to the semilunar cartilages is not seen in the United States with anything like the frequency that it is encountered in England. It has been my experience, on visiting England, that it is not unusual to see two or three semilunar derangements listed on the day's operative schedule in certain of the larger clinics, most of the patients being miners, football players or rugby players. The greater number of such derangements, there, as compared to those occurring in America, may be explained by the fact that in America the population as a whole does not participate in the more active sports to the extent that the people of the British Isles do, and that coal miners here work in seams of greater height, permitting erect posture, instead of a cramped position with the knees partially flexed, so favorable to injury to a semilunar cartilage. The injury is always produced by indirect trauma, but not necessarily while the patient is engaged in an active pursuit, or while he is standing. I can recall one patient who had locking of the knees caused by typical bucket handle type of fracture of both internal semilunar cartilages at different times a few years apart, while he was in bed. The primary locking occurred in one knee when he was turning over in bed preparatory to arising, it occurred in the other knee in his sleep, and he was awakened by the pain. In several other cases, the attack occurred during the act of swinging around a newel post at the foot of a flight of stairs. However, the majority of injuries came about while the patient was playing some game or performing some task entailing considerable strain on the knee joint. According to our series of 256 cases, as would be expected, there is a preponderance of persons in early adult life, with males predominating 4:1 (tabulation)

Most information on the subject of injury to semilunar cartilages has been gleaned from the British literature. However, of recent years, increased interest has been evidenced in the United States by various contributors (2, 3, 13, 15, 16, 17). A review of cases at The Mayo Clinic was undertaken in order to correlate the experience during a number of years. As so often happens when cases come to one's attention rather sporadically, the continuity of clinical observations is interrupted and a review is necessary properly to evaluate the clinical signs. My chief reason for the review was that I found that joints were being opened occasionally, and it seemed to me too often, in cases in which the patients gave good

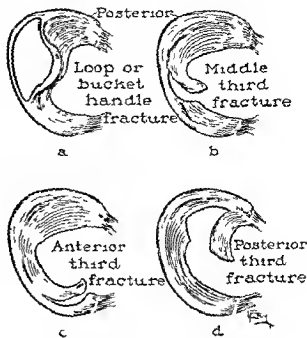


Fig 1 Common types of fracture of internal semilunar cartilage

clinical histories of injuries to the semilunar cartilages, but who presented operative data that were put down as negative or insufficient to account for the symptoms. An experience of this kind is exasperating, to say the least. The opportunity for free and easy exploration of the cavity of the knee joint is by no means parallel with the opportunity to explore the abdominal cavity. It is clearly evident, therefore, that an exact diagnosis is most desirable in operating on the knee joint. I reviewed, with much interest, the records of 256 patients, from whom 261 cartilages had been removed. Five patients had had more than one cartilage excised. Many of the patients had been seen a considerable time after the operation and the outcome had been definitely ascertained. The end-results concerning the others had been determined either by correspondence with the family physician or with the patients themselves. The results are known in 238 (94 per cent) of the 256 patients.

#### SYMPTOMS

The symptoms in these cases are chiefly subjective, therefore, in industrial compensation cases one must be on one's guard. The patient's account of the actual happenings at the time of the original injury is often fogged, either because of the rapidity with which the various factors causing the injury occurred or because of lack of observation. Much interesting information may be obtained during the study of a group of his

tories of this kind which cannot be readily tabulated, and the gleaner of such information must present in more or less arbitrary fashion the meat of his observations. In my grouping of cases, those called typical were those in which the primary injury to one of the cartilages occurred during more than usual activity, and it was characterized by pain in the knee, coming on suddenly, accompanied by immediate disability with inability to extend the knee (locking), and followed by swelling. Usually there ensued irregular attacks with greater or less effusion in the joint, complete return to normal occurring between the attacks. The exceptions, wherein normal function between attacks was not attained, were in most instances those cases of bucket handle fracture because, after the locking the loop failed to slip back from the intercondylar notch and extension could not be completed, although all other signs, such as pain, soreness, and swelling, subsided. In the typical cases, the manner of production was also considered the knee partially flexed, the foot everted, and the strain clearly on the internal lateral ligament. Of 234 patients with derangements of the internal semilunar cartilage, 170 (76 per cent) gave typical histories. Of 22 patients with derangements of external cartilages, 14 (63 per cent) gave typical histories. More will be said of injuries to the external cartilage later in the paper. In comparatively few cases was there an opportunity to see the patient at the time of the original injury. The average length of time elapsing from the time of onset until operation was 3.76 years, the extremes varied from a few weeks to many years.

#### DIAGNOSIS

The diagnosis is not always easy. Kleinberg suggested the use of oxygen inflation and roentgenological examination, since it is possible to outline the menisci by such means. Kreuzer has suggested the use of an instrument similar to the cystoscope, which he called the arthroscope, but he did not report on its use. The roentgen ray, unless oxygen inflation is employed, is useless, the meniscus does not cast a shadow, except in rare instances in which calcification has partially occurred. I have not used the oxygen inflation method and cannot, therefore, speak of its value.

The main points to be considered in the diagnosis are (1) injury to the knee generally indirect and sustained usually during some active pursuit and (2) recurrent attacks with intervals of complete freedom both subjectively and objectively. The attacks are characterized by pain, disability,

swelling, lack of complete extension, a feeling of something amiss in the joint, and usually some tenderness (if the injury is to the internal cartilage) over the anterior border of the internal lateral ligament at the joint line. In cases in which the external cartilage is the seat of the injury, the pain and tenderness are usually referred to the outer side.

The pain accompanying the injury is sudden and may be excruciating, completely disabling the patient. Rarely is it definitely localized, but the patient will usually state that it is in the anterior part of the joint and mostly on the inner side. When the external cartilage is at fault, the pain, as has been mentioned, is referred to the outer side of the knee and often posteriorly as well. Because of lack of any large series of cases of injury to the external cartilage, however, definite data are not afforded. In this series there were 22 injuries (roughly 8.6 per cent of the total) or 1 injury of the external cartilage to 12 injuries of the internal cartilage. As the attacks recur and increase in frequency, the pain may not be so severe. Pain was present in all the cases in this series.

The swelling which comes on immediately after the attack is due to synovial effusion and is probably protective in character. Occasionally, hemorrhage into the joint is encountered, but it is rarely of any significance. Perarticular thickening is not present, except that which occasionally is felt along the attachment of the internal semilunar cartilage to the capsule at the site of the injury. As the attacks become more frequent, the subsequent effusion is less in quantity and disappears more quickly. Swelling was mentioned in 224 (87 per cent) of the cases.

Inability completely to extend the knee was noted in 101 (39 per cent) of the cases at the time of examination. In most of these a bucket handle fracture was present with the loop caught in the intercondylar notch.

In the 234 cases of injury to the internal semilunar cartilage it was recorded in 181 that the injury occurred in flexion, but in 11 cases the patient stated that the injury was sustained with the knee in the extended position. I am inclined to believe that the latter is too high an incidence and that closer questioning might have cut down this number considerably. In the remainder of the cases the records with regard to the injuries were indefinite. Localized tenderness is usually present over the anterior attachment of the internal semilunar cartilage if a tear of the bucket handle type is present, and particularly if the loop is caught and held in the intercondylar notch.

In chronic cases of this type, when the swelling has all disappeared and lack of extension is still persistent, palpation of the triangular area bound by the margin of the internal condyle, the tuberosity of the tibia, and the patellar ligament, will often disclose thickening. Although the patient may be aware of a feeling of insecurity in the knee, lack of extension may be appreciated by the patient only when he is told to stand erect with the feet even, and force back both knees into complete extension. It can then be readily seen that the affected knee does not go back as far as the normal one. A distinct localized swelling, often fluctuating, may be a cyst of one of the semilunar cartilages. These are said to be more common in the external cartilages. Allison and O'Connor published reports of 3 cases. Phemister has also written concerning them. In this series one external cartilage was removed on account of a cystic condition. I have seen a number of other cases in which the slight symptoms did not seem to warrant surgical intervention.

Habitual or recurring dislocation, throwing the knee out, catching, and locking are all terms used by the patient in describing the recurrent attacks. The number of lockings will vary from a few to a hundred or more. No doubt in strong vigorous men, particularly athletes, it is possible for the violent destructive action of the oft repeated force to so fragment the semilunar cartilages that the offending tag or portion causing the locking is disintegrated and ultimately absorbed.

The differential diagnosis may be difficult in certain cases in which the history is not typical. Many patients complain of a mild catching sensation in the front part of the knee referred to the inner side. Fisher stated the belief that the tag like prolongation of the infrapatellar fat pad is responsible for many of these, and advised manipulation followed by reeducation of the quadriceps muscle. I have had no experience with this type of case, but it is probable that many useless explorations have been done on account of these indefinite symptoms. The various types of arthritis, specific and non specific, may be difficult of differentiation. In arthritis there is often more than one joint involved and there is also perarticular thickening, and its presence in a suspected case should be sufficient to put the surgeon on his guard. Loose osteochondral fragments produce locking that is more transient in character, appreciable swelling rarely follows and roentgenograms will disclose the offending bodies. A knee joint should not be opened until a satisfactory roentgenogram has been made, unless circumstances do not permit such a procedure.

Early in the course of osteochondritis dissecans, especially if it occurs at adolescence before the line of demarcation or cleavage of the body is established and the area is really loosened so that it will show in the roentgenogram, the patient complains of a feeling of instability or insecurity in the knee. Carefully taken anteroposterior roentgenograms with slight flexion of the knee, and lateral roentgenograms, will often show a suspicious looking area on the internal condyle proximal to the insertion of the posterior cruciate ligament. Sir Robert Jones and Sir Arbuthnot Lane, years ago, called attention to the fact that tuberculosis of the knee seemed to occur in some cases in which symptoms suggesting injury to the cartilage had been present. I am inclined to believe that the swollen, congested synovial membrane, the result of arthritis, may have caused symptoms akin to mechanical derangement. I have never known tuberculosis to occur in a knee in which a definite lesion, such as a fractured cartilage, was found.

#### SURGICAL PROCEDURE

If repeated locking has occurred, or if the complaint cannot be relieved in primary cases by manipulation, and the condition is causing inconvenience to the patient, other things being equal, there is no reason for withholding the benefits of operation, and the offending meniscus should be removed. General anesthesia is favored in The Mayo Clinic and is commonly used, but the operation can be carried out under local anesthesia by the infiltration method about the knee or a combined caudal and spinal injection. The latter has the advantage over the infiltration method as it permits the use of the tourniquet.

The patient should be placed on the operating table so that the bend of the foot piece of the table comes directly under the knee. Previous preparation is not necessary, other than a general bath and shaving of the affected knee. Benzine and iodine are applied with the leg elevated, and the skin is cleaned. The knee is held in the flexed and in the extended positions so that the wrinkles in the skin will be cleaned. Too vigorous preparation by scrubbing and poulticing may readily irritate the skin. A tourniquet is applied to the middle of the thigh, and the draping is carried so that the covering of the leg and foot is sterile. The foot of the table is dropped and the leg falls with it. The operator sits on a stool high enough so that he may hold the foot between his own knees, that are draped with a sterile sheet. This enables him to exert and invert the leg with and still use both hands.

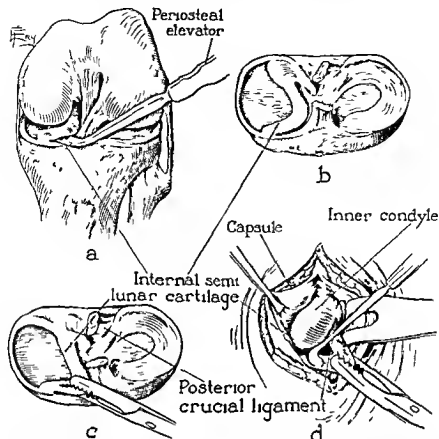


Fig 2 a Bucket handle fracture of the internal semilunar cartilage showing its relationship to the head of the tibia and the condyle of the femur, periosteal elevator lifting up the cartilage b diagrammatic representation of position assumed by bucket handle fracture on the head of the tibia c, Martin forceps grasping the cartilage d knife cutting anterior attachment

A straight incision is made about 15 or 2 centimeters to the inner side of the patellar tendon, starting at about the level of the middle of the patella and extending downward to just below the level of the head of the tibia. Such an incision is far enough back to be convenient and still not injure that portion of the capsule known as the internal lateral ligament.

Galeazzi has called attention to the frequency with which injury to the crucial ligament is associated with injury to the semilunar cartilage. I am inclined to believe that in cases in which instability of the knee follows operation, the crucial ligaments have been injured at the time of the accident in a large percentage of cases and that too often the instability is attributed to injury to the internal lateral ligament at the time of operation. Although I question the importance of the internal lateral ligament in this rôle, I do not mean to infer that the ligament should be roughly handled

or severed. The nearer the incision is made to the juncture of the anterior with the middle third of the cartilage, the better the opportunity to examine and remove the internal meniscus. By careful maneuvering and manipulation of the internal cartilage after it is loosened in front (Fig. 2) practically the entire cartilage can be removed through a small antero internal incision (Fig. 3). If a definite lesion cannot be found in the portion that has been removed but the symptoms have been definite, the posterior portion of the cartilage should be removed through a postero internal incision. Care should be taken in separating the cartilage from the internal capsule not to cut into the substance of the capsule, or its function as an internal lateral ligament will be interfered with. It is best to leave a little of the cartilage attached, cutting through the substance of the meniscus itself just at the periphery, a knife designed by Frieberg is of assistance and the various

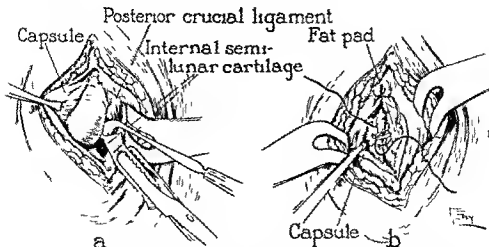


Fig 3 a, Meniscus pulled forward in the intercondylar notch, and the posterior extremity being divided with Frieberg's knife, b, the wound sutured in layers

types of scissors and snares used for certain nasal operations often facilitate the removal

The wound should be closed after the tying of any vessels that can be seen in the periarticular structures, and the tourniquet is removed after a cotton dressing has been applied and firmly held by a bandage. Either a plaster cast or a posterior splint is put on and left for about 5 days, but it must be remembered that prolonged fixation prolongs convalescence. On its removal, the patient is encouraged to move the knee. In 8 days the stitches are removed and walking is encouraged, the contra-indication being too much effusion. Rarely is it necessary to perform aspiration, some effusion is to be expected. Physiotherapy as a postoperative procedure is not carried out as a routine in the clinic, since it rarely appears to be necessary for the patients are usually young and vigorous, and full function is quickly regained.

When a fracture is found in a meniscus, there can be no doubt about the necessity of removing it. If the fracture or tear is in the anterior three fifths of the cartilage, one is justified in being satisfied with the removal of that portion, but if the tear is in the back part it is not sufficient and the entire cartilage should be removed.

If a lesion is not found in the meniscus, but the symptoms have been definite, there being no doubt about the lockings and the pain referred to the inner side of the knee, it is best to remove the cartilage. In a number of instances, such a procedure has been proved to be justifiable by the finding of a pedunculated flap which could not possibly be seen through an anterior incision. Blind work and too vigorous or ill directed work from in front in the effort to loosen completely an internal cartilage with a bucket handle frac-

ture lying in the intercondylar notch may result in severing one of the crucial ligaments. In a considerable number of cases in which attacks of locking had occurred for many years, it was a satisfaction to note, on the pre-operative record, that considerable laxity of the joint was present, for although the attacks of locking were relieved after removal of the meniscus the laxity persisted. Undoubtedly, many patients who report dissatisfaction following removal of a cartilage due to a lax knee have such a condition before operation, but all attention being focused on the cartilage, no attention is paid to it and so no record is made of the instability. The disability must be considerable to warrant any of the procedures recommended for reconstruction of the crucial ligaments.

#### RESULTS

*Results for all cases.* As I have stated 238 of the 256 patients (94 per cent) have been traced. One hundred eighty-three (77 per cent) are relieved of all trouble, 34 (14 per cent) are improved, and 21 (9 per cent) are not improved, thus, 91 per cent were cured or markedly improved. The 9 per cent of patients not improved are confined to the border line group in which the complaint is sufficient to warrant surgical procedures, and although the clinical diagnosis was by no means clear-cut, it was thought best, in view of the safety of modern surgical procedures, to explore the knee. There have been no fatalities in the series, and no infection more serious than a low-grade skin infection in a few of the cases. It must never be lost sight of that infection is a possible risk, and the question so often asked by the patient advised to have an operation on the knee as to whether or not the letting out of the "joint water" will or will not result in a stiff knee bears



testimony that the lingering illness and often amputation or death that follow infection of the cavity of the knee joint has been indelibly impressed on the mind of the laity. The knee joint should be opened with the same rigid attention to technique that should be employed in any major surgical procedure, less care certainly can not be countenanced. Knee joints should not be opened in offices and homes.

*Results for cases in which pathological change was not demonstrable.* In the series of cases under consideration there were 42 cases in which at the time of operation, the operative note stated that the lesion present was not sufficient to account for the patient's symptoms, but that because of the definite subjective symptoms the meniscus was removed. These cases are most interesting. Seven patients, 6 with lesions of the internal cartilage and 1 with a lesion of the external cartilage were not traced; thus 35 patients were traced. Thirteen (37 per cent) were cured, 8 (23 per cent) were improved, and 14 (40 per cent) were not improved. It is my hope that with the advantage of more experience in diagnosis this group will be smaller from now on. It is clear, however, that in spite of the absence of a demonstrable fracture or tear in the cartilage, cure does result in more than a third of the cases comprising this group that have been designated as without sufficient evidence of a lesion to account for the symptoms. It is justifiable I believe, to deduce from these data that some cases present definite symptoms of derangement, in which the condition is probably merely hypermobility of the cartilage.

#### SUMMARY

An accurate diagnosis is essential before operation is performed on the knee joint because a free and satisfactory exploration of the cavity of the knee cannot be carried out. The results of this type of surgery are good. Seventy-seven per cent of the patients operated on recovered completely and were free of all trouble. Injury to the crucial ligaments sustained at the original injury may give a certain amount of permanent laxness to the joint that should in no way be attributed to the results of operative procedures on the meniscus. The cures following removal of the external semilunar cartilage did not quite equal those obtained by removal of the internal cartilage. The percentage of cures is reduced by the inclusion in the group of cases in which a definite lesion was not found at operation, in this group there were only 37 per cent of cures.

#### AGE AND SEX INCIDENCE<sup>1</sup>

Age years	Patients
10 to 19	27
20 to 29	116
30 to 39	66
40 to 49	37
50 to 59	9
60 to 69	1

<sup>1</sup>There were 215 males and 43 females. 210 patients (56 per cent) were between the ages of 20 and 50.

The most common fracture or tear found was the bucket handle or loop type, 86 in the internal cartilage and 5 in the external cartilage, these fractures constituted more than a third of the series. This occurrence is higher than is found in most published statistics. In 78 per cent of the series, a fracture or a tear, or a distinctly loose cartilage was present.

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## THE MECHANISM OF GLUTEAL GAIT

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THE residual paralyses of anterior poliomyelitis are as a rule erratic in distribution and not uncommonly an isolated paralysis of a single muscle may be observed. A single isolated paralysis of the tibialis anticus muscle with resulting talipes valgus deformity occurs relatively frequently. Paralysis of the gluteus medius muscle is often associated with other paralyses but it is unusual to observe disability of locomotion resulting from paralysis of this muscle only. This condition has been noted but once in our clinic during the past 5 years, during which time more than 600 patients with residual paralyses of anterior poliomyelitis have been studied. Paralysis of the gluteus medius muscle associated with other paralyses often results in a deformity and disability which must be considered minor as compared with the deformities and disturbance of function from the associated paralyses. A paralytic spine, knee, or foot as a rule demand treatment in preference to the deformity resulting from paralysis of the gluteus medius. An isolated paralysis of the gluteus medius muscle however, results in a relatively more important disturbance of locomotion and, as is demonstrated in the case reported in this paper, the resulting disability may be greatly improved by surgical treatment.

The origin of the gluteus medius is from the lateral surface of the ilium between the iliac crest and posterior gluteal line above and the anterior gluteal line below. It also arises from the gluteal aponeurosis covering its outer surface. The fibers converge to a strong flattened tendon which is inserted into the lateral surface of the greater trochanter. The muscle is partly covered by the gluteus maximus muscle and conceals the gluteus minimus muscle. It receives its innervation through the superior gluteal nerve from the sacral plexus (fourth and fifth lumbar and first sacral).

The gluteus medius is the chief abductor of the hip and is of special importance in supporting and balancing the pelvis when the patient stands on one foot. When a normal individual stands on one foot and flexes the opposite thigh on the abdomen the pelvis remains either on a horizontal plane or is slightly elevated on the side on which the knee is flexed (Fig. 1). But if the integrity of the gluteus medius is impaired and cannot successfully oppose the force of gravitation, then the equilibrium of the pelvis is lost and the pelvis will drop on the

side on which the knee is flexed (Fig. 2). The dropping of the pelvis on the affected side when one stands, can be observed by noting the relative levels of the buttocks. This observation is known as Trendelenburg's sign and occurs when the function of the gluteus medius is impaired, and in cases in which the mechanics of the hip joint are deranged as in congenital dislocation of the hip, ankylosis of the hip in adduction, sciatic scoliosis, and coxa vara. Impairment of the gluteus medius muscle function, either by paralysis or loss of the fulcrum on which it acts (Fig. 3) with resulting loss of stability and dropping of the pelvis, alters the center of gravity of the body in relation to the base of support. In order to maintain balance and equilibrium when standing on the affected side, the patient must list the trunk toward the affected side in order to have the center of gravity fall over the center of the base of support (Fig. 7). The list toward the affected side is repeated with each step and the patient walks with a "gluteal gait."

The "gluteal gait" is also observed in congenital dislocation of the hip. Following reduction of a congenitally dislocated hip the distance between origin and insertion of the gluteus medius muscle is returned to normal. The muscular function is re-established and with the femoral head within the acetabulum there is a firm fulcrum on which the gluteus medius can effectively balance the pelvis and successfully oppose gravitation. The dropping of the pelvis and the "gluteal gait" gradually disappear after the child becomes ambulatory following the reduction and restoration of the mechanics of the hip joint.

Spontaneous dislocation of the hip occasionally complicates paralysis of the muscles controlling the hip joint (Fig. 5). The mechanism of the production of spontaneous dislocation of the hip joint is a derangement of the normal action of the muscles surrounding the hip joint. The derangement may result from the residual paralyses of anterior poliomyelitis affecting the muscles of the hip joint controlling abduction (gluteus medius) and extension (gluteus maximus). The normal unopposed flexors and adductors undergo contracture and the involved extremity is held in the position of instability (flexion, and adduction) which results in dislocation. The case here reported presented a paralytic subluxation of the

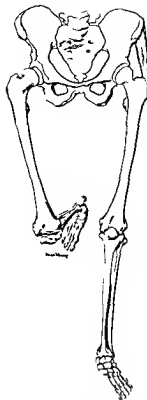


Fig 1



Fig 2

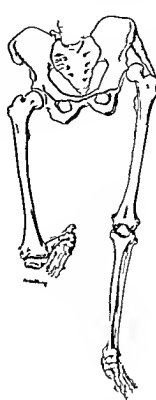


Fig 3

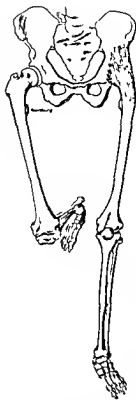


Fig 4

Fig 1 Balancing the pelvis when standing on one extremity depends on a firm fulcrum provided by the femoral head within the acetabulum and normal function of the gluteus medius muscle

Fig 2 Impairment of gluteus medius function results in dropping of the pelvis when patient stands on the affected extremity since the gluteus medius muscle cannot successfully oppose the force of gravitation

Fig 3 Impairment of function of the gluteus medius muscle, either by paralysis or loss of the fulcrum on which it acts results in a dropping of the pelvis when patient stands on the affected side

Fig 4 Bony ankylosis of the hip joint in the optimum position for function stabilizes the pelvis in relation to the extremity and prevents dropping of the pelvis and a list of the trunk when patient stands on the involved extremity

femoral head however only the abductor (gluteus medius) was paralyzed. It may be assumed that the gluteus maximus was partially paralyzed at the onset with subsequent restoration of function or that contractures of the adductor muscles resulted in a flexion adduction deformity. Subluxation of the femoral head results in dropping of the pelvis on the unaffected side when patient stands on the affected side, since the firm fulcrum on which the gluteus medius acts is lost. The local paralyses about the hip joint are as a rule associated with paralyses disturbing stability and mobility of the knee and foot, also abdominal paralyses with resulting spinal curvature and paralyses of the muscles of the upper extremity may be present. The associated deformities may be more serious lesions than the subluxation of the hip making the campaign of treatment a complicated problem in certain cases.

Since the "gluteal gait" in our patient was secondary to the dropping of the pelvis and a shifting of the center of gravity, it was clear that any attempt to improve the gait must necessarily reestablish the stability of the pelvis in relation to the affected extremity. It was thought that fusion of the hip joint in the optimum position for ankylosis would gain the desired stability between the pelvis and the extremity (Fig 4). This reasoning could be fairly accurately tested by the application of a short plaster of Paris hip spica encasing the pelvis and thigh of the affected extremity. Accordingly, the spica was applied and the improvement of the patient's gait justified surgical treatment to obtain bony ankylosis of the affected hip in the optimum position for function. This was accomplished by means of an intra articular and extra articular fusion of the hip joint (Fig 6), with the result that the patient



Fig 5 Roentgenogram showing paralytic subluxation of the left hip, secondary to gluteal paralysis



Fig 6 Roentgenogram showing bony ankylosis of the left hip in the optimum position for function following intra articular and extra articular fusion

is now ambulatory with a most gratifying improvement in her gait (Fig 8). In this case we have demonstrated that a stable hip ankylosed in the optimum position for function is a better functional hip than an unstable one and that by opposing the effect of gravitation the gluteus medius muscle and the fulcrum on which it acts play an important role in balancing the pelvis when patient stands on one leg. Impairment of the function of the gluteus medius muscle affects posture, locomotion, and the support of the pelvis, as manifested by the list of the trunk, the "gluteal gait," and the Trendelenburg sign, respectively.

#### CASE REPORT

C D, white female aged 10 years, was admitted to the Orthopedic Clinic March 3, 1920. Her chief complaint was a pronounced list of the trunk toward the left side when walking or while standing on the left foot. The patient had infantile paralysis at the age of 13 months. The paralyzes involved both lower extremities. There was a gradual restoration of muscle function with a complete return of function of the right lower extremity but an incomplete return of function of the left lower extremity. The patient's past history was otherwise unimportant. The general physical examination was essentially negative except for the muscular and skeletal systems.

The patient walked with a marked left gluteal gait. Standing on the left lower extremity caused dropping of the pelvis and a lowering of the gluteal fold on the right. In order to maintain balance while she stood on the left lower extremity the trunk listed markedly to the left. There were no paralyzes of the upper extremities. The anterior and lateral abdominal muscles were normal except for a weakness of the right lateral abdominal muscles which functioned against gravity. It is possible that the partial paralysis of the right lateral abdominal muscles influenced the degree of list of the trunk to the left. The muscles of

the right lower extremity were normal except for a complete paralysis of the tibialis anticus muscle which resulted in a mild talipes valgus deformity and hyperextension of the great toe secondary to overaction of the extensor hallucis longus muscle. Examination of the muscles of the left

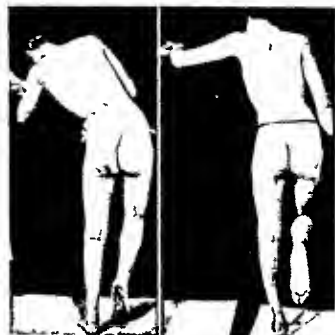


Fig 7 left To maintain balance and equilibrium with dropping of the pelvis the patient must list the trunk toward the affected side in order to shift the center of gravity of the body over the center of the base of support. The list toward the affected side is repeated with each step and the patient walks with a gluteal gait.

Fig 8 Following arthrodesis of the hip joint in the optimum position for function, the list of the trunk and gluteal gait were markedly improved.

lower extremity revealed a total paralysis of the gluteus medius muscle. The left tensor fascia femoris muscle was normal. The remaining muscles controlling the hip joint were weak; however, the rotators, extensors, flexors and adductors functioned against gravity. The muscles controlling the knee joint were weak but all functioned against gravity and resistance. The muscles controlling the foot were normal. Examination of the left hip joint revealed free painless range of motion in all directions except abduction. The femoral head could be palpated posteriorly and there was mild telescoping. There was a moderate contracture of the adductor tendons and a scaphoiding of Scarpa's triangle. The left lower extremity was three quarters of an inch shorter than the right. Radiographic studies of the pelvis and hip joints demonstrated a partial dislocation of the left femoral head from the acetabulum.

cova valga and retarded development of the acetabulum, femoral head and femoral shaft.

The application of a short plaster-of-Paris hip spica, encasing the pelvis and left thigh in the optimum position for fixation of the hip joint resulted in a marked improvement of the patient's gait. On April 27, 1929, an intra-articular and extra-articular fusion of the left hip joint was performed. The left hip joint was immobilized by means of a plaster-of-Paris spica in a position of 30 degrees flexion, 10 degrees abduction and neutral as to rotation. Bony ankylosis between the pelvis and femur resulted with the hip joint in the stated position. There was half an inch apparent shortening. Ankylosis of the hip joint resulted in a most satisfactory improvement. The patient now walks with a very mild list of the trunk to the left and complains of practically no discomfort or disability while sitting.

A STUDY OF HYPERTROPHIC OSTEO-ARTHRITIS OF THE SPINE<sup>1</sup>

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**A**RTHRITIS of the spine, particularly the hypertrophic form, is a frequent lesion in individuals past the fourth decade. Many writers consider the condition productive of nerve root pressure disturbances variously called radiculitis, neuritis, and intercostal neuralgia. In an attempt to determine the frequency of hypertrophic arthritis and associated nerve root involvement, a study was made of 80 cases, patients over 40 years of age, who presented themselves with a wide variety of complaints. The group was limited to those beyond the fourth decade because of the recognized greater frequency of osteo arthritis at that period of life, and presented a small cross-section of that age period. Forty-five admissions were on surgical and 35 on the medical service. The majority were railroad employees, who belonged to the laboring class. The group comprised 74 males and 6 females. The average age was 52.4 years, the oldest being 75 and the youngest 40 years.

The frequency of hypertrophic osteo arthritis of the spine has been reported in few instances. The lesion is regarded as a common finding. Garvin, in a series of 2,000 patients more than 50 years of age, in whom roentgenograms of the kidneys, ureters, and bladder were taken, found hypertrophic arthritis of the spine in 67 per cent of the males and 40 per cent of the females. Homman reported a group of 16 carefully studied cases of arthritis of the spine in which the hypertrophic form was present in 75 per cent. In this unselected group of 80 individuals, 44 patients or 55 per cent showed an osteo arthritis ranging from very early to very advanced types of the Marie-Strumpell variety.

The incidence of the lesion according to the age period is shown in Figure 1. Wallace states that the youngest was 27 years of age while the average age was over 40 years. The average age in Homman's report was 49 years. The average in this series is 55.6 years. Since the majority of cases were in males no conclusions can be given as to the relative frequency in the sexes. Dickson states that 75 per cent of his cases occurred in males.

Osteo arthritis in my series was found most often in the dorsolumbar region (Fig 2). The cervical spine was not routinely roentgenographed. Of the 44 cases, both the thoracic and the lumbar vertebrae were involved in 21, 47.7 per cent, the

lumbar alone in 16, 36.3 per cent, and the thoracic alone in 7, 15.7 per cent. The third and fourth lumbar and the two lower thoracic vertebrae were most commonly affected. The fourth lumbar was most often involved (23), 52.2 per cent, the third lumbar next (21), 47.7 per cent, following which the twelfth thoracic (21), 47.7 per cent, and eleventh thoracic (20), 45.4 per cent, showed the changes. Next in frequency were second lumbar in 18, 40.9 per cent, first lumbar in 17, 39.6 per cent, fifth lumbar in 14, 31.3 per cent, tenth thoracic in 13, 29.5 per cent, ninth thoracic in 6, 13.6 per cent, and eighth thoracic in 3, 6.8 per cent.

The etiology of the condition has never been satisfactorily explained. A wide variety of causes has been assigned. Gonorrhoea, typhoid fever, infection of the teeth and tonsils, gastro-intestinal disorders, nasal sinus disease, faulty metabolism, and exposure to heat and cold have all been designated as factors.

Focal infection as a cause has received major consideration. Homman reported that the majority of cases examined showed oral infection in the teeth or tonsils or both. Garvin found 72 per cent of his cases had peri-apical infection, and, including these with pyorrhea, 94 per cent had dental sepsis, 15 per cent of the women and 20 per cent of the men showed tonsillar sepsis, 75 per cent of the 39 men had prostatic infection. In this series, focal infection, chiefly of the teeth, tonsils, sinuses and prostate was found in 45, 56.3 per cent, of the 80 cases examined. Thirty of the 44 (68 per cent) of the cases having osteo-arthritis had focal infection, in 15, 18.7 per cent, focal infection was present but no osteo arthritis was found.

Attempts have been made to identify a specific bacterium of which the streptococcus has been the principal organism studied. Poynton and Payne were the first to show experimentally the infectivity of acute rheumatic fever. Beattie and Yates demonstrated that streptococci cultured from cases of acute rheumatic fever caused arthritis in rabbits. Others have described streptococci associated with acute and chronic arthritis variously as streptococcus viridans, streptococcus anhaemolyticus, and streptococcus non haemolyticus. Recently, Small has described a non-haemolytic streptococcus, isolated from acute rheumatic fever and selected arthritis cases. He later published the results of treatment of these cases with a spe-

<sup>1</sup>Submitted to University of Pennsylvania Post Graduate School in partial fulfillment of requirements for degree Master of Medical Science

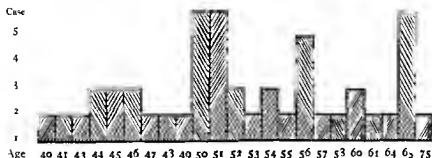


Fig. 1 The age incidence of osteo arthritis of the spine

cific antiserum and antigen. In the chronic arthritis group he was able to isolate the organism in 11 cases of chronic arthritis, 2 cases of vague rheumatic pains, and 1 case of acute myositis.

An attempt was made in this study to isolate the organism described by Small from cases of spinal arthritis of the chronic group with hypertrophic changes in the vertebrae. Throat cultures in 44 cases showing the lesion were made by inoculating swabs taken from the tonsillar pillars, tonsils, and abscessed teeth on blood agar plates of hydrogen ion concentration 7.6 according to the description of the cultural methods used by Small. Streptococci which presented macroscopic features resembling those of the cardio arthritis group were subcultured in beef infusion broth of hydrogen ion concentration 7.6. The indifferent streptococci thus isolated were tested for agglutination phenomena: the specific antiserum of the streptococcus cardio-arthritis in a 1:2000 dilution being used; a dilution according to Small not likely to pick up associated serologic strains in a group reaction. Control agglutinations were made in which a bacterial suspension of the streptococcus cardio arthritis and its specific antiserum were used. Non-haemolytic streptococci were isolated from the throats of 25 osteo arthritis cases. Agglutination with the streptococcus cardio arthritis antiserum occurred in no instance, indicating that the non-haemolytic streptococci thus isolated did not belong to the group described by Small as occurring in selected cases of chronic arthritis.

The pathology of the condition has been well studied. Most authors describe the process as beginning in the intervertebral discs with progressive absorption and calcification extending to the bone, resulting in apposition and fusion of the vertebrae by bony deposits. With this there occur proliferative changes at the edges of the bodies of the vertebrae resulting in lipping and exostosis formation. The latter may be so marked as to cause locking of the vertebrae. This disease, how-

ever, is not limited to the bodies and intervertebral discs but extends to the lateral and articular processes causing narrowing of the intervertebral foramina with pressure on the nerves and ankylosis of the small intervertebral joints. In the thoracic region ankylosis between the vertebrae and ribs may occur. Involvement of the spinal ligaments also takes place. In the majority of cases these pathological changes are more marked on one side of the spinal column and tend to spread along the involved side, with the result that the symptoms are more severe on that side. The process usually begins in the lumbar region and tends to spread upward involving the entire spine. As a rule, other joints, especially those of the fingers, are attacked. Cases vary in degree of involvement and rate of progression.

Clinically, as well as pathologically, hypertrophic osteo-arthritis of the spine has been mentioned as a cause of pressure on the spinal nerve roots emerging from the spinal column. This pressure causes nerve pain and tenderness which in the intercostal nerves supplying the abdominal wall may simulate visceral disease. It is the opinion of most writers that the bone spurs are not responsible factors in producing the pressure, but rather a soft tissue exudate. Nathan, in a study of the neurological conditions associated with spondylitis states that, clinically, the neural symptoms are those of moderate radicular or spinal irritation or compression produced by a periradicular exudate thrown out by the inflamed periosteum of the spinal canal and the intervertebral foramina. He found experimentally that the vertebral changes which are induced by inoculating dogs with streptococci are similar to those in the skeleton elsewhere. The changes are endosteal and subperiosteal inflammation. In the spine this exudate involves the epidural space and vertebral notches, it is of such a nature that it must, perforce, cause root or spinal irritation or compression. Carnett states that intercostal neuralgia after the age of 35 or 40 years is most commonly due to arthritis of

the spine. Gunther calls attention to the radicular syndrome in hypertrophic osteo arthritis of the spine and in a study of 30 cases demonstrated bilateral radicular sensory disturbances which correspond to the vertebrae involved.

In this series the 44 patients showing the lesion were carefully studied to determine the neural involvement. The method of examination for detection of this condition is that described by Carnett, consisting of the A and B test for abdominal nerve tenderness, pressure over nerve trunks and terminal distribution, and skin fat pinch. Patients who showed positive signs by these methods were then examined by the methods employed by Gunther in his study, namely, sensory examination with a cotton tuft, pin point, heat and cold, and pinching, in an attempt to determine the particular nerve trunks affected. Of the 80 patients examined, 25, 31.3 per cent, showed nerve root involvement, 17, 21.25 per cent, showed peripheral nerve tenderness with evidence from cutaneous tests that nerve roots were involved. None of these, however, had a subjective complaint which could be attributed to the nerve root involvement. Of these 17 cases, 10, 58.8 per cent, had osteo arthritis and 7, 4 per cent, did not. Eight patients, 10 per cent, showed nerve root pressure signs and did have subjective complaints arising from this condition. Of these 8, 4 had extensive spinal osteo-arthritis while 4 had no clinical or X-ray evidence of arthritis. This would indicate that osteo-arthritis may in some instances produce nerve pressure and in others may not. The accessory factor is not accounted for, but from the fact that the 8 who showed symptoms had recently suffered or were suffering at the time from a systemic infection, the majority from influenza, the inference may be made that a latent periradicular inflammatory process was lighted up.

The 8 cases showed characteristic features. Pain, paresthesia, and hyperesthesia were prominent symptoms. The pain in each instance was dull, aching, always intensified by motion, and was frequently worse at night. Limitation of spinal movement, most evident in flexion and lateral bending, was noted in all cases. Dejerine's sign, considered pathognomonic of radiculitis, was present in all. Sensory alterations were distributed according to the spinal root topography. In each, a recent or associated systemic infection, chiefly upper respiratory, was noted. In none of the 8 was the blood Wassermann reaction positive. Three showed excessive lumbar lordosis, 2, a slight scoliosis. Of the 17 showing nerve tenderness without complaint 6 had scoliosis, 3 excessive

Cases

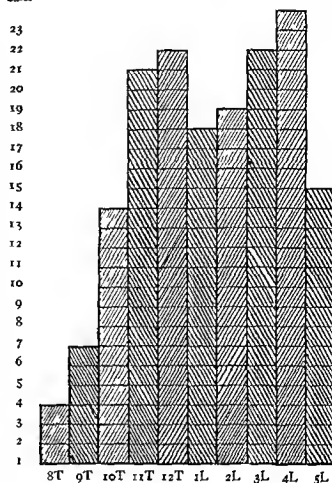


Fig. 2. Vertebrae showing frequency of involvement

lordosis, and 5 excessive kyphosis. The incidence of backache was determined for the reason that low back pain has been attributed by some to osteo arthritis of the spine. In this series, 19, 23.7 per cent, complained of backache, 13, 16.2 per cent, had backache and osteo-arthritis, while 31, 38.7 per cent, had no back complaint but osteo-arthritis was present. Six, 7.5 per cent, had backache without osteo-arthritis being found.

Considerable attention has been given to the simulation of visceral disease by radicular syndrome. Chute, in 1905, reported 5 cases of osteo-arthritis of the spine in which the referred pains simulated lesion of the kidney, prostate, or seminal vesicles. In 1917, Blaine called attention to the simulation of symptoms of renal or ureteral disease in cases showing only spondylitis. In a series of 87 cases of spondylitis, Vanderhoff found 40 who complained of abdominal pain. In 17 of the 40 the presence of visceral disease could be demonstrated, and the part played by spondylitis was either questionable or negligible. In 23 cases careful and complete studies excluded visceral disease as a cause of the patients' complaints. In



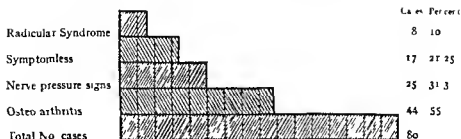


Fig. 3 The relative frequency of osteoarthritis, peripheral nerve tenderness and the radicular syndrome

1923 Sloan called attention to the frequency of confusion in diagnosis of these cases stating that "the prevalence of spinal arthritis, its frequent association with abdominal pains, and the many mistakes in diagnosis which have been observed have been truly astonishing." More recently, Gunther has given a complete description of the radicular syndrome in hypertrophic arthritis in which he describes the characteristic symptoms arising from involvement of the various spinal nerves. Woolsey has emphasized the necessity of recognition of the radicular syndrome in the presence of abdominal symptoms, citing a case of spondylitis simulating a non-existent lesion. Parker and Adson report 8 cases of compression of the cord or its roots by hypertrophic osteoarthritis in which the signs and symptoms were similar to those of extramedullary tumor of the spinal cord. Dickson and O'Neal report 3 cases of osteoarthritis of the spine complicating disease of the abdominal viscera. Carnett has repeatedly called attention to mistakes in diagnosis resulting from this syndrome. Five, 6.25 per cent, in this series simulated visceral disease. Four of the 8 showing the radicular syndrome had been operated upon without relief. 2 of these were osteoarthritis with nerve root involvement and 2 were typical intercostal neuralgias as described by Carnett. The case histories of the 5 simulating visceral disease are cited.

**CASE 1** Mrs. R. B. K. aged 51 years housewife was admitted to the hospital August, 1928 complaining of pain in the right upper abdomen. The onset was 7 years earlier and was attributed to striking the chest. For the past 4 years she had been frequently nauseated. Itching and tingling sensation occurred on the right side of the abdomen and chest. The distress was aggravated by jarring, sneezing and coughing. There was constipation associated with gas formation. Three weeks before admission she suffered a mild influenza. Past illnesses were malaria, incipient tuberculosis in 1901 and influenza in 1928. She had been married 15 years, no pregnancies. She was told by two physicians that she had gall bladder disease and operation had been recommended.

Essential findings on examination were tenderness of the right upper abdomen, chiefly under the right costal margin

and marked limitation of movement of the dorsolumbar spine. The X-ray examination revealed chronic fibroid phthisis but no evidence of pathology in the gastro-intestinal tract. Moderately advanced osteoarthritis of the ninth, tenth and eleventh thoracic vertebrae; the kidneys were normal in size and position; gall bladder by the Graham-Cole method was apparently normal.

Laboratory reports showed the urine negative, leucocyte count 4,000, blood Wassermann negative, Van den Bergh 4 units, bile removed by Lyon's non surgical drainage was normal and contained no calcium bilirubin crystals; blood chemistry normal.

Attention directed to the spine disclosed that the seventh, eighth and ninth thoracic intervertebral spaces and intercostal nerve trunks on the right side were markedly tender to pressure. Movement of the spine was limited in the dorsolumbar region. The full movement caused pain in the back and abdomen. Hyperesthesia of the skin supplied by the seventh, eighth and ninth intercostal nerves on the right side was definite. Injections of novocain into the paravertebral spaces between the seventh and eighth, eighth and ninth and ninth and tenth vertebrae on the right resulted in a loss of hyperesthesia corresponding to the area of tenderness and hyperesthesia previously determined on examination. During the effect of the nerve block pain was absent.

A diagnosis of radiculitis simulating gall bladder disease was made. Spinal fixation and bed rest gave relief. The resumption of full activity caused a recurrence of the complaint. The later appearance of associated pain in the extremities convinced the patient that her abdominal distress was not due to gall bladder disease.

**CASE 2** H. M. aged 50 years laborer was referred January 15, 1929 for operation for subacute appendicitis. He had had a severe attack of influenza 3 weeks before admission to the hospital and right lower abdominal pain followed. There had been no nausea or vomiting. Pain was aggravated by jarring, sneezing and coughing. He also complained of some pain in the right chest and below the left costal margin. For many years he had suffered with stomach trouble chiefly in the spring and fall which consisted of pain in the epigastrium about an hour after meals. At these times vomiting occurred. There had recently been an undetermined loss of weight.

The essential findings were normal temperature and tenderness in the right lower quadrant which was severe when the muscles of the abdomen were held tense. The intercostal nerve trunks in the dorsolumbar region were tender while the xiphogastrophic and xiphoinguinal nerve trunks were markedly tender.

The laboratory reported the urine negative, the leucocyte count 5,000 and the blood Wassermann negative. The X-ray plates of the gastro-intestinal tract suggested a probable tumor of the pylorus while the X-ray examination of

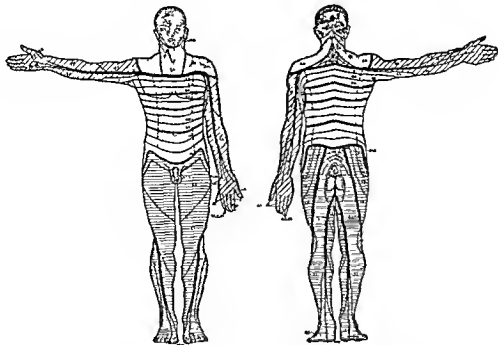


Fig. 4 The radicular sensory innervation (From Mayer J Am M Ass, 1918)

the spine revealed an extensive osteo arthritis of the lower thoracic and all the lumbar vertebrae.

Examination of the spine showed an excessive lumbar lordosis. Motion in the dorsolumbar region was limited. The right paravertebral interspaces between the tenth and twelfth vertebrae were quite tender. Hyperaesthesia of the skin of the abdomen supplied by the tenth, eleventh, and twelfth right intercostal nerves was definite. Paravertebral injection of novocain blocking these nerves resulted in a loss of hyperaesthesia previously determined.

A diagnosis of radiculitis simulating appendicitis was made. On account of the previous history of stomach disorder, loss of weight, and the X-ray findings, an exploratory laparotomy was performed. The stomach was normal, the appendix was atrophic, showed no signs of acute pathology, and was not removed.

On discharge the patient was free of pain, probably from enforced bed rest. Nerve trunk tenderness and hyperaesthesia, however, persisted.

CASE 3. T. T. M., aged 57 years, conductor, was admitted to the hospital February 20, 1929, complaining of pains throughout the abdomen, aggravated by jarring and by acute infections such as colds. Onset of illness was 10 years ago with severe pain and numbness in the left shoulder. Later, pain occurred in both hips and extended into the legs. Thoracic pain was present in the back and extended about the abdomen. The condition had been practically continuous since onset, except for short periods of remission. He complained a great deal of gaseous eructations but no vomiting.

He had had measles and diphtheria in childhood, typhoid fever and dysentery in 1898, in 1923 had fallen from a height striking on buttocks, appendectomy had been performed in 1924 without relief.

On examination no spinal deformity was found. The flexion, extension and lateral bending of the spine was limited and painful. Abdominal tenderness in both lower quadrants was present. The right lower six intercostal nerve trunks supplying the abdominal wall were markedly tender, as best demonstrated when the muscles were tense. Cutaneous hyperaesthesia corresponding to the area sup-

plied by the eighth, ninth and tenth right thoracic nerves was readily made out. The X-ray plates of the spine showed an advanced osteo arthritis of the eighth, ninth, and tenth thoracic and fourth and fifth lumbar vertebrae.

Spinal fixation gave temporary relief.

CASE 4. C. S., aged 56 years, conductor, was admitted to the hospital February 10, 1929. He complained of pain in the right lower abdominal quadrant. He had had a mild attack of influenza one month before. There was no gastric disturbance and the bowels were regular. The temperature was 97.6 degrees. Examination elicited tenderness but no rigidity in the right lower abdominal quadrant. Tenderness was greatly accentuated when the abdominal muscles were tense. The right lower intercostal nerve trunks showed a tenderness from the spine laterally. The intercostohumeral, iliohypogastric and ilioinguinal nerve trunks were exquisitely tender.

The laboratory reported the urine negative, the leucocyte count 5,400, and the blood Wassermann negative.

Cutaneous tests outlined an area of hyperaesthesia supplied by the ninth to the twelfth right intercostal nerves. Paravertebral block of these nerves resulted in loss of hyperaesthesia over this area. The X-ray examination of the spine revealed osteo arthritis of the third lumbar vertebra but none was evident in the lower thoracic region.

A diagnosis of intercostal neuralgia simulating appendicitis was made. After a few days rest in bed, the pain disappeared. Later examination showed a persistence of the area of hyperaesthesia.

CASE 5. Mrs. F. A. P., aged 49 years, housewife, was admitted to the hospital August 1, 1928. She stated that for the past 20 years she had had sharp pains across the abdomen. The skin over the back, chest, and abdomen was always sensitive. Coughing and jarring aggravated the condition. The abdominal pain was chiefly in the lower left abdomen and radiated to the bladder region. She had recently had an acute upper respiratory tract infection.

Past illnesses consisted of a nervous breakdown in 1910 and severe influenza in 1918. Examination showed general abdominal tenderness chiefly over the left side. There was no rigidity. With the muscles made voluntarily tense

tenderness was exquisite. The supra orbital intercosto humeral and all intercostal nerve trunks were markedly tender. Excessive lumbar lordosis was present.

The temperature was 98 degrees, the leucocyte count 3,400, the urine negative, and the blood Wassermann negative. The X-ray examination of the gastro-intestinal tract showed no evidence of pathology. Cystoscopic examination revealed no pathology in the bladder, ureters or kidneys. The spine showed no evidence of osteo arthritis.

Hyperesthesia to touch, cold and heat was present over the lower abdomen to the left supplied by the lower intercostal nerves.

A diagnosis of intercostal neuralgia simulating an upper genito-urinary tract disorder was made. Bed rest and correction of the lordosis gave temporary relief. All symptoms recurred in a few weeks.

#### SUMMARY

Eighty unselected patients over 40 years of age were studied to determine the incidence of osteo arthritis of the spine and the frequency of an associated radicular syndrome. Of these 44 per cent showed evidence of hypertrophic osteo arthritis. The average age of the patients was 55.6 years. The dorsolumbar region was the most often involved. Throat cultures from the 44 showing osteo arthritis did not yield the streptococcus cardio-arthritis in any instance. Local infection was present in 56 per cent of all cases and in 68 per cent of cases showing osteo arthritis. Twenty-five, 51 per cent, showed by neurological examination evidence of pressure on the spinal nerve roots. In seventeen, 21 per cent, no symptoms were found attributable to the arthritis. Eight, 10 per cent, had the radicular syndrome in which the complaint was entirely due to this condition. Four of the eight had osteo arthritis, whereas 4 had none visible to the X-ray. Of the 8 with the radicular syndrome, 5 had been operated upon without relief. In 3, the radicular syndrome simulated visceral disease.

#### CONCLUSIONS

1. Hypertrophic osteo arthritis of the spine is a common affliction in individuals beyond the fourth decade.

2. The majority of cases are silent showing no symptoms referable to the involvement of spinal nerve roots.

3. A small percentage have the radicular syndrome which may simulate visceral disease.

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## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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NOVEMBER, 1930

#### LIVER ATROPHY

LIVER atrophy is a purely descriptive term indicative of no specific pathological process, used loosely to denote the end result of various inflammatory conditions of the liver, such as acute and subacute yellow atrophy, and cirrhosis. These lesions differ only in the duration, intensity, and extent of the inflammation. For the sake of clarity, they might better be termed "acute," "subacute," and "chronic" hepatitis. To regard the acute and subacute forms as way-stations on the road to the chronic type or cirrhosis would lead to a better understanding of their relationship.

The known causes are manifold. They comprise such substances as chloroform, carbon tetrachloride, tetrachlorethane, tribromethylalcohol, phosphorus, arsenic in its various forms, the toxins of eclampsia and exophthalmic goiter, parasites such as the *treponema pallidum*, and bacteria and their toxins and so forth. More than one cause may be responsible in any particular instance.

The intensity and duration of the exposure to the cause determines the variety of lesion

resulting. A brief exposure to a virulent poison like chloroform produces an acute hepatitis, which is characterized by a swollen, tender liver, secondary to the cloudy swelling of its component hepatic cells. This stage is soon followed by a reduction in the size of the liver due to collapse of the necrotic liver cells. If death ensues, no fibrosis or regeneration is seen. Should recovery occur, the debris is carried away by the phagocytic endothelial cells and regeneration of normal liver tissue takes place in the as yet undamaged connective tissue framework of the liver.

A less severe, though more prolonged, exposure, in this instance months instead of weeks, would produce the subacute type. With the lesion of such duration there is marked connective tissue proliferation which restricts the regeneration within a heavy fibrous tissue framework, producing the so-called "nodular adenomatous hypertrophy," characteristic of subacute hepatitis. When the process is further prolonged, a true chronic hepatitis or cirrhosis appears. That an intercurrent infection arising either in the biliary tract or portal blood stream, augments the degree of fibrosis has been noted by Whipple and Sperry, Schultz, Hall and Baker, and Moise and Smith.

Fortunately, certain observations on diet have proved of great help in protection against these lesions. Opie and Alford showed that while a high fat diet increased the susceptibility of livers of dogs to necrosis following the administration of chloroform, a carbohydrate diet had a distinctly protective action. Moise and Smith, investigating the toxicity of chloroform and the degree of necrosis on

various types of diets, found chloroform most toxic on a fat diet and relatively less so on a mixed diet, a carbohydrate diet, and a protein diet in the order named. Whipple and Davis produced a central necrosis in the livers of dogs, giving chloroform either as an anæsthetic or subcutaneously and found that regeneration occurred most rapidly on a high carbohydrate diet or mixed diet. Mann and Magath have shown that glucose is essential for the optimum maintenance of dehepatectomized dogs.

Bollman has observed that in dogs with a biliary cirrhosis produced by obstruction of the common bile duct, life may be prolonged up to 10 months if they are fed on a diet of syrup, bread, and milk, but that a diet of meat is rapidly fatal death occurring within a week or 10 days. He also noted that ascites appeared within a few hours in these jaundiced animals after feeding them meat or meat extract and that it disappeared rapidly with the substitution of large amounts of carbohydrates. Somewhat later he found that in dogs with experimental portal cirrhosis, produced by feeding carbon tetrachloride or tetrachlorethane a diet consisting of milk and corn syrup afforded protection to the liver cells and aided regeneration. The dogs fed on a high protein diet chiefly of meat, showed symptoms of profound toxæmia, more marked destruction of liver cells and very little capacity for regeneration.

In the atrophies of the liver, recognition of their true nature is of primary importance. It is well known that these patients are exceedingly poor surgical risks that they are more susceptible to toxic agents, and that their wounds heal slowly. These facts have demonstrated the lack of hepatic reserve far better than the laboratory. Obviously the surgeon should be guarded in accepting such a patient for operation.

Luetic hepatitis should always be excluded before the administration of arsenicals. True biliary colic may be very difficult to distinguish from the severe distress of hepatic pain. In the acute and subacute forms of hepatitis, the jaundice is often described as being of an orange rather than greenish hue. The stools are usually pigmented and the urine may contain leucin and tyrosin crystals, indicative of liver necrosis rather than insufficiency. Umber has described a characteristic "fetor hepaticus" or "amine" breath. The blood urea rises only as a terminal feature presumably due to a nephrosis caused by the retained bile acids. True evidence of insufficiency of the known liver functions is almost impossible of laboratory proof.

These data have proved helpful in the consideration of each individual case of jaundice as it confronts and perplexes us. Atrophy of the liver persists as a refractory surgical problem since in arriving at a diagnosis one must differentiate stone, neoplasm, stricture, and infection of the biliary tree. The bugbear of gastro intestinal hemorrhage still remains in spite of the Talma Morrison omentopexy and Walter's adaptation of their procedure to the gastrohepatic omentum. F. C. FISHBACH.

## CARCINOMA OF THE COLON

AT a recent hospital clinical pathological staff conference two cases were considered which emphasize in no uncertain manner the need for constant vigilance in the diagnosis of carcinoma of the colon.

The two patients were between fifty and sixty years of age and both gave, among other more striking but less characteristic symptoms, the story of a decided *change in their habits of bowel movement during the previous few months*. One of these patients was admitted with acute intestinal obstruction for

which an ileostomy was immediately performed, no diagnosis being made. No barium X-ray study was subsequently carried out. Six weeks later the ileostomy was closed with resulting obstruction, peritonitis, and death. Autopsy revealed an early annular carcinoma of the colon at the hepatic flexure. No metastases were found either in the regional lymph nodes or in the liver.

In the second patient barium was given by mouth and the entire gastro-intestinal tract was pronounced essentially normal. At a laparotomy the gall bladder, which was moderately thickened and contained several stones, was drained and a right ovarian cyst was removed. The pyloric opening was noted to be small but the stomach was not much dilated. The patient vomited repeatedly and a gastro-enterostomy was made at a second operation. The vomiting persisted and one week later an ileostomy was performed and the patient succumbed. At autopsy a very early, partially-obstructing carcinoma of the colon was found at the splenic flexure. There were no metastases.

Several years ago I heard Doctor Daniel F. Jones, of Boston, make a remark to the effect that each year, in his opinion, two or three

patients with carcinoma of the colon were turned away from every large out-patient department with the advice that they should regulate their bowels. It is evident, however, that the younger medical men, who see the patients in many of these out-patient clinics, are not alone in their failure adequately to heed the all-important statement of the patient that his *'bowels do not move as they used to'*.

Operating surgeons should, personally, (1) take a careful history, (2) observe and palpate the abdomen, (3) make a rectal examination, (4) use the proctoscope and sigmoidoscope, (5) utilize the evidence of the barium enema, but discount the results when negative or inconclusive, and (6) at laparotomy explore with care every inch of the colon.

Particularly in patients over thirty-five years of age the fact of a *change in the habits of the colon* should make the surgeon so suspicious of cancer in this organ that he will not allow his attention to be diverted from the large bowel either by incidental pathology or by lack of evidence of marked obstruction, until he has proved beyond all doubt that a lesion is not present there.

CLARENCE E. BIRD

# MASTER SURGEONS OF AMERICA

## JOHN JONES

THE finest traditions of organized science spring from the impulses which animated the early masters. The life of Dr. Jones is intimately associated with the earliest and most inspiring traditions of the science of surgery in America.

He came of sturdy Welsh lineage. His grandfather, Dr. Edward Jones, emigrated from Wales in the ship "Welcome" with William Penn and his colony. He married the daughter of Thomas Wynne, speaker of the Penn Assembly. His son, Dr. Evan Jones, married Mary Stephenson, also of the Penn Colony, and settled in the town of Jamaica, Long Island, where the subject of this sketch was born in 1729. He was the eldest of four sons and his academic schooling was conducted by his father and mother in their home and in a private school in New York City.

It was the wish of John's father that he should study medicine and at the age of eighteen he was placed under the tutorship of Dr. Thomas Cadwallader, one of Philadelphia's most distinguished physicians. He was there brought in intimate relationship with the socially elect of Philadelphia, who were the friends of his own family and whose influence was in later years to form a most important background for his professional life in that city.

Jones was a conscientious and hard working student, ambitious to excel in all the opportunities offered by his illustrious preceptor.

America at that time had no medical college nor any hospital with an organized clinic where a student could be trained in course, and the facilities for clinical study were limited to the private patients of his preceptor.

After completing his training under Dr. Cadwallader, Jones went abroad, carrying letters from his preceptor to the master anatomists and surgeons of Britain and France. In London he became the pupil and eventually the intimate friend of Percival Pott, whose surgical clinic at St. Bartholomew's was justly celebrated. He also took the lecture course of William Hunter in anatomy and became a friend of John Hunter who was completing his course in medicine.

After finishing his courses of study in London young Jones went to France. He had acquired a reading and colloquial knowledge of the French language and first became a student at the University of Rheims where he received his degree.



JOHN JONES  
1729-1791





of Doctor of Medicine in 1751 From Rheims he returned to Paris, where he remained until April, 1752, with Professor Petit in his work in anatomy and in the surgical clinics at Hôtel Dieu with Professors Le Cat and Le Dran From Le Dran, who was one of the first urological surgeons of his time, he learned to do lithotomies with skill and facility From Paris he went to the University of Leyden and thence to London to be again with Pott and the Hunters, ending his tour of foreign study with the elder Munro in Edinburgh

In 1753, Dr Jones returned to New York to open an office and put in practice the accumulated knowledge gained from study with the teachers abroad

Dr James Mease, his biographer, commenting on the warm friends Jones had made among the master surgeons of Britain and France quotes some of the ideas which animated this brilliant young student, who had formulated the following course for the scientific surgeon

"Besides a competent acquaintance with the learned languages, which are to lay the foundation of every other acquisition, he must possess an accurate knowledge of the structure of the human body, acquired not only by attending anatomical lectures, but by frequent dissections of dead bodies with his own hands

There must be a happiness as well as art, to complete the character of the great surgeon He ought to have firm steady hands and be able to use both alike, a strong clear sight, and above all a mind calm and intrepid, yet humane and compassionate, avoiding every appearance of terror and cruelty to his patients amid the most severe operations Whoever has acquired just and general ideas of the nature of a disease will seldom be at a loss how to apply them on particular occasions, and to him who wants those ideas, no rules or directions will be of much consequence "

In 1758, during the war between France and the British Colonies in America, when the invasion of New York was threatened at the Battle of Lake George, Dr Jones enlisted as a military surgeon The French general in chief command, General Baron D'Escaux was dangerously wounded and was taken prisoner by the British Having learned of Dr Jones' skill and that he had been a student of Le Dran, the French General sent for him to treat his wounds The American surgeon continued to care for Baron D'Escaux after he was transferred to New York

At the end of the campaign Dr Jones returned to his surgical practice His fame had now become widespread in the Colonies and his services were soon in demand everywhere His skill in doing the operation of lithotomy, which in a very brief time he had brought from a procedure of great risk and high mortality to one of safety, brought him a well merited reputation Moreover, Percival Pott had proved a loyal friend to his capable pupil and was unflinching in commending Dr Jones to patients in America who sought his counsel This cordial attitude on the part of Mr Pott and the fine training under Professor Le Dran in urologic

surgery which hitherto had been in bad repute in America, gave impetus to Jones' reputation as one of the most skilful and outstanding surgeons of his time. He performed the first lithotomy done in New York. Dr Mease wrote of him "He had acquired a facility in operating to which few surgeons had arrived. I have seldom known him longer than three minutes in a lithotomy and he has sometimes finished the whole in one minute and a half."

At the organization of the medical school in the College of New York (now Columbia University) Dr Jones was appointed professor of surgery. He had had a careful training in obstetrics and up to this time obstetrics and surgery were taught in the same lecture course by the same teacher. He came back from Europe with the conviction that surgery was a distinct and separate branch of practice and should be taught and practiced as such. He not only was the first professor of surgery in America but from that time on was accorded the title of Father of American Surgery.

Since his boyhood he had suffered greatly from asthma. His health from this malady became so impaired he finally determined to go to London to be with his old friends there with the hope that the fogs of London would afford him relief. Strange as it may be, he did grow better and stronger in this environment, and attributed his improvement in health to this change in climate. He again attended the clinics of Mr Pott and the lectures on anatomy by Dr Hunter. The personal courtesies and social hospitalities extended to him by them and notably by Mr Pott were a life long inspiration to him. While in London he succeeded in raising the funds needed to complete New York's first hospital.

The threatened outbreak of the War of the American Revolution cut short his stay in England and he returned to New York, enlisted for the war, and served with Warren, Bard, and Morgan in the organization of the medical department of the Colonial Forces. In 1775 his chief and principal work on surgery was published. Its title was *The Plain Concise Practical Remarks on the Treatment of Wounds and Fractures*. At the beginning of the war there was a great dearth in the Colonies of young surgeons who were capable of treating gunshot wounds and fractures. This book so replete with knowledge Jones had acquired in the clinics of Le Dran and Pott proved an invaluable handbook for the young military surgeons in this war and for many years afterward to the surgeon in civil practice.

When the British forces occupied the city of New York its three or four leading surgeons Jones among them, found it necessary to leave, and inasmuch as he had previously been benefited by the climate of Philadelphia and had many friends there he took up his residence and opened an office in that city in the summer of 1778. On the resignation of Dr John Redman in 1780 from the Pennsylvania Hospital, Dr Jones was unanimously elected to succeed him and continued to serve on its staff until his death eleven years later. When in 1787 the

Medical College of Philadelphia was organized, Dr Redman was elected president and Dr Jones vice president

He became not only the physician of Benjamin Franklin but his intimate personal friend and was remembered by Dr Franklin in his will Dr Jones has written a most interesting and detailed account of the last illness of his illustrious patient which his biographer incorporated in the narrative of his life The intimacy and delightful fellowship which bound the great philosopher to his surgeon friend had its counterpart earlier in his life with Percival Pott and was to be greatly enriched by a notable friendship with President Washington, whose physician he had been for years and whom he attended for some indisposition the afternoon of the day Dr Jones died

Among the contributions to the surgical literature of the time in addition to the volume on the *Treatment of Wounds and Fractures*, were *Camp and Military Hospitals*, *The Diseases Incident to Armies with the Method of Cure*, *Graduation Thesis at the University of Rheims, 1751*, *Account of the Last Illness of B Franklin, 1790*, *A Case of Anthrax, 1791*

He had trephined and opened the dura in a patient with delirium and symptoms of cerebral abscess eighty days after a head injury which terminated in recovery This was one of the first operations on the brain in America and is reported in his work on the *Treatment of Wounds and Fractures*

His notable executive ability in organizing the Department of Medical and Surgical Service at the beginning of the American Revolution has previously been mentioned So active was he in the public affairs of his city and State that he was made a senator in the State of New York

This cultivated gentleman of versatile accomplishment was an illustrious surgeon of international note, a loyal patriot a splendid citizen, and a devoted friend of humanity He was an honor to the profession he loved and the guild which his achievements distinguished

The life and ideals of this noble-minded teacher and master should be an inspiration to all who have followed the course and development of the science of surgery in America

ANDREW STEWART LOBINGIER

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

WILFRED BROWN MD FACS OMMA

JAN VAN HUEN

THE national or rather international reputation attained by van Forest would be expected to stimulate Hollanders to take up medicine and practice it in their own country. Consequently, following Forestus by a few years another Hollander was to gain a great reputation. Jan van Heurne more commonly known as Heurnius was born at Utrecht in 1543 twenty one years later than Forestus. There being no University in Holland he began his studies at Louvain in 1561 as a pupil of Cornelius Gemma. Following his training there he began the usual wanderings of the young medical man of the time to the important universities of the continent. His first point was Paris. Here he studied under Ludovicus Durettus the great student of Hippocrates and obtained from him the interest in the physician of Cos which was to initiate his later activity in studying the works of the ancients. After Paris he went to Padua and came under the tutelage of Hieronymus Cappivaccus Fabricius of Acquapendente and Hieronymus Mercurialis. In 1571 he obtained his doctor's degree at Leida. At this time the revolution led by William of Orange against King Philip was gaining headway and it appeared he might accomplish something at home. Accordingly he returned to Utrecht and began to practice. As he had joined the Protestant cause and embraced its religion he was *persona non grata* to the Spanish soldiery and had to put up with some indignities but he refused to be driven out. At this time his interest in the ancient physicians especially Hippocrates stood him in good stead for he apparently worked along this line when he was not busy with his practice and thus may have taken his mind off the troublous times his country was going through.

In 1575 the University was established at Leyden and 3 years later he was called to it as professor of medicine. He accepted and was able to practice there the clinical method of teaching that he had learned in his student days. He remained in Leyden the rest of his life constantly associated with the University of which he later became Rector serving six terms in that office. He died in 1601.

Heurnius sprang into prominence soon after his return to Holland and gained a high position due to his powers of diagnosis which soon brought him in contact with the ruling powers and gave him many prominent patients. One of these was the Count of

Noortcarries who was suffering from jaundice the cause of which could not be made out. Heurnius discovered that it was due to poison which was being given him by the Spaniards. The Count was Governor of Utrecht and so one of whom the Spaniards were anxious to be rid. He also took care of Count Egmont the Governor of Flanders and Artois, who chose him as his physician even though Heurnius was a protestant and Egmont a catholic. Egmont's religious belief was not strong enough to make him countenance the tyranny that Philip II of Spain was trying to introduce into the Netherlands. We have then the picture of a clever and learned medical man well thought of at court closely connected with important people and able to use this for a sinecure but still working constantly at his science for though he did not begin to publish until moderately late in life his publications were numerous and worth while.

In 1587 his first book appeared under the title "A New Science of the Practice of Medicine" *Praxis Medicinæ nova ratio* and from then on they appeared with but little time between. The year after his death 1602 two volumes one on diseases of the eye ear nose teeth, and mouth and another on diseases of the chest were published posthumously but it is probable that the greater part of the labor of seeing them through the press was performed by Heurnius himself, though his son had to do with the actual publishing.

Though primarily an internist Heurnius does not neglect diagnostic surgery and even goes so far as to describe the indications for some surgical procedures. For headache he advises phlebotomy, arteriotomy and the actual cautery. The last he also advises together with scarification and local bleeding in hydrophobia and his description of this disease is the most important part of the work on

Diseases of the different parts of the human head. It is exceedingly clear and shows an excellent knowledge of the subject in hand. Likewise in the portion of the book devoted to paralysis Heurnius comes so near making important discoveries that one wonders how he happened to miss them, his observations are so complete and clearly expressed but his knowledge of anatomy and physiology was too incomplete. His discussion of atrophy in connection with paralysis is one which would have been of greater value had he applied it to the treatment of disability following fractures.

I. HEVRNII  
VLTRAIECTINI  
DE MORBIS  
QVI

IN SINGVLIS PARTIBVS  
HVMANI CAPITIS  
INSIDERE CONSVEVERVNT

*Hic artificiosa à methodo, & incredibili facilitate, morborum Idæe,  
Cause, & cuiusque cause morbosæ, partisque ægræ Signa  
Prognoses, & Curatio Rationalis & Empirica  
graphice depinguntur*

Cum Rerum & Locorum insignium valissimo Indice.



LVGDVNI BATAVORVM,  
EX OFFICINA PLANTINIANA,  
— Apud Franciscum Raphelengium  
cIo. 12. xciiii.



## REVIEWS OF NEW BOOKS

CAMPBELL presents a valuable orthopedic text,<sup>1</sup> which should appeal to the student or practitioner because of its clear, easy style and its comprehensiveness. The arrangements of subjects are rather unique and most satisfactory: the main divisions being affections of joints, affections of bone, affections of soft tissues, affections of the nervous system, static deformities, and congenital anomalies. The increasing scope of orthopedic surgery is reflected in the well organized chapters on fractures, dislocations, and bone tumors. Selected useful operative procedures are presented with discussions of indications and technique. Chapters on ankylosis and arthroplasty command especial attention. Other outstanding chapters are those on examination of the patient, tuberculosis of joints and anterior poliomyelitis.

FREMONT A. CHANDLER

THE second part of Volume I of *Chirurgie der Brustorgane*<sup>2</sup> by F. Sauerbruch deals with the surgical treatment of pulmonary tuberculosis, neoplasms of the lung, echinococcus and actinomycosis of the lungs, the surgical treatment of bronchial asthma, and pulmonary lues. The book also contains a very comprehensive bibliography covering the subject matter treated in volume I as well as the index. The general appearance of the second half of the first volume is similar to that of the first half and brings the chapters discussed up to date.

In discussing the work as a whole, for those who are not acquainted with the previous additions, it should be said that Sauerbruch's *Chirurgie der Brustorgane* is the outstanding work on surgery of the chest. It is the standard reference text emanating from the largest and best known chest surgery clinic in the world. It is excellently written and profusely illustrated with diagrams, X-ray pictures, actual photographs, drawings, and some of the most beautiful color plates that the reviewer has ever seen. Sauerbruch's *Chirurgie der Brustorgane* should be in every library, and will be found on the shelves of every surgeon or internist who is interested in thoracic conditions.

RALPH BOERNE BETTMAN

A MOST interesting book to own and read is Beckman's *Treatment in General Practice*<sup>3</sup>. It covers general medical treatment in an unusual manner. As the author states, it is in no sense his own attempt to be authoritative in this enormous field. On every subject and on every page there is prolonged quotation and reference. Thus the book is a collection of medical opinions on every subject,

with intelligent and interesting editorial comment. With rare exceptions the author's own opinions are not intruded. On controversial problems (and they are many) both sides are represented. As is to be expected, the surgeons are not adequately praised for their treatment of hyperthyroidism, but a surgeon is allowed to present the discussion of medical versus surgical treatment of peptic ulcer. As an illustration of the manner in which the book is done, take the portion on the treatment of peptic ulcer. First Dr. Arthur Dean Bevan's discussion of the medical versus surgical treatment is quoted for 2 pages, Sippy's treatment is quoted from Sippy for 3½ pages, Alvarez on the treatment of duodenal ulcer is quoted for 3 pages, Andresen on the treatment of gastric hemorrhage for 4 pages, and Bastedo for 1. These quotations are consecutive and are interrupted by very brief editorial comment. Most of the other important medical problems, such as the treatment of lobar pneumonia or heart disease, are handled in this same way. Reference is made and authority quoted on a great number of special medical problems from anthrax to sea sickness. Sections on diseases of the skin, genito-urinary tract, and nervous system, acute poisoning and obstetrics are included. On the whole, this book represents very extensive reading, intelligent selection of material, and stimulating discussion.

PAUL STARR

THE fifteenth volume of Pauchet's *Practical Surgery*<sup>4</sup> includes monographs on free scalp grafts for the replacement of eyebrows, the radical treatment of frontal sinusitis, in which the frontonasal canal is enlarged by means of a small curette and the tampon passes into the nasal cavity. An interesting case of cutaneous sarcoma of the arm is given in detail, the tumor was removed *in toto* and a pedicle flap from the chest used to cover the defect. A diaphragmatic hernia of the stomach in a boy of 13 is beautifully illustrated, the interesting item being that the X-ray plates did not reveal the abnormality.

Subserous cholecystectomy is well described, the French school is swinging more and more toward cholecystomy in order to treat the concomitant hepatitis. Gastric, duodenal, and jejunal ulcers are described in detail, most of them representing late relapses or complications. Lipectomy of the abdominal wall with esthetic transplantation of the umbilicus is well described by Mornard. Of less value are monographs on extirpation of the seminal vesicles and on testicular grafts, the latter based on Voronoff's work. The volume contains two hundred superb illustrations by that sterling artist Dupret. Pauchet's volumes should be of especial value to the beginner who is still orienting himself.

GEORGE DE TARNOWSKY

<sup>1</sup> TEXT BOOK ON ORTHOPEDIC SURGERY. By Willis C. Campbell. M.D. F.A.C.S. Philadelphia and London: W. B. Saunders Company, 1930.

<sup>2</sup> DIE CHIRURGIE DER BRUSTORGANE. By Ferdinand Sauerbruch. 3d ed., Vol. I, part 2. Berlin: Julius Springer, 1930.

<sup>3</sup> TREATMENT IN GENERAL PRACTICE. By Harry Beckman. M.D. Philadelphia and London: W. B. Saunders Company, 1930.

<sup>4</sup> LA PRATIQUE CHIRURGICALE. LESISTÈME. By Victor Pauchet. Vol. XV. Paris: Gaston Doris & Co., 1930.



IN an excellent little volume Pascalis<sup>1</sup> recounts his personal experiences with various surgical affections. Especially valuable are his comments on tendon repair, Pott's fracture, Buerger's disease and penetrating wounds of the abdomen. The treatment of ascites which has given him the best results consists in tapping followed by the introduction of six liters of sterile hot water. In Pascalis's experience over 60 per cent of all cases of cancer of the sigmoid and rectum are diagnosed too late for radical extirpation. Wherever possible he favors mobilization of the descending colon and sigmoid resection of the cancer area and suturing of the proximal sigmoid to the sphincter (if not involved) or to the levator ani. In prostatectomies he condemns packing the vesical pouch as being painful and as leading to urinary retention infection and secondary hemorrhage. Freyer's irrigation with hot saline has in Pascalis's hands always checked the vesical hemorrhage. In describing the treatment of retroversion uteri Dolcis is given sole credit for the technique known in America as the Barrett operation.

GEORGE DE TARNOWSKY

THE subject of the mechanism of the larynx has been approached from a purely biological standpoint by Dr. Negus<sup>2</sup> who has traced the development of the organ from its lowest form to the highly developed mechanism known as the human voice box. In the author's own words much has been written about the larynx its physiology, anatomy and the diseases which attack it and still this small organ performs its work shrouded in mystery. It cannot be said that anything detailed is known about its mechanism either in the animal kingdom or in man. It is generally known as the organ of voice but it must be observed that thousands of species which have a larynx never or practically never make use of voice.

Dr. Negus has traced the reasons for its existence and the steps of its evolution in response to demands made on it. We learn that the larynx first appeared as a mechanism guarding the lung fields and that throughout its evolution this protective measure seems to be its chief function even in the higher vertebrates. The vocal cords were originally muscular valves designed for respiratory purposes but later were used for the production of sound and ultimately for speech. To Dr. Negus the human larynx demands attention purely because it is one rung in the evolutionary ladder. No mention is made of the various diseases which attack the larynx and the book is devoid of all clinical tables and statistics.

One need not know especially anatomy or medicine to understand this work. It is self-explanatory and the author has succeeded in unraveling many mysteries of the larynx and teaching us many new

things. The text is of good paper and extremely well illustrated. This is a monumental work and one that will be referred to many times by laryngologists and teachers of voice. One cannot praise Dr. Negus too highly for his work.

JOHN F. DELPH

ONLY a few years ago the first edition of Wright's excellent and worthwhile book on *Applied Physiology*<sup>3</sup> was reviewed. It has become a popular book among medical students and clinicians. The interest of the author in his work is manifested by the fact that only a year has elapsed since the publication of the previous edition. A number of sections have been altered, old matter being deleted and new data and facts introduced. A new section of sixteen pages on conditioned reflexes has been added which augments the value of the book. The book is useful not only in that it contains much clinical physiology, but assists a great deal in understanding and appreciation of symptoms.

A. C. IVY

THE rich experience of Koranyi<sup>4</sup> with a subject in which he has carried on pioneer, fundamental investigations is reflected in his book on diseases of the kidneys. The book had its origin in a series of clinical lectures which incorporated the results of studies by the writer and his associates during a period of 35 years. The present work has preserved the lecture form and includes a survey of much of the literature on the subject. No attempt has been made to provide a systematic presentation for use as a textbook of diseases of the kidney. The first five lectures are devoted to the biological and clinical foundation of functional pathology, diagnosis, and treatment. The remaining lectures include the following subjects: high blood pressure, nephrosclerosis, uraemia, the nephroses, acute glomerulonephritis, the kidney of pregnancy and of mercury poisoning and the chronic nephritides. The final chapter contains an exceptionally well balanced review and summary, the points of divergence in the view point of pathologist and clinician are described and the principles of classification of kidney diseases are elucidated.

WALTER H. NADLER

THE monograph by H. Morrison Davies on *Surgery of the Lung and Pleura*<sup>5</sup> is one of a system of books entitled *Regional Surgery*, edited by A. P. Bertwistle.

In perhaps no other branch of surgery is another textbook as welcome as in the field of thoracic

<sup>1</sup>APPLIED PHYSIOLOGY. By Samson Wright, M.D., M.R.C.P. 3d ed. New York and London: Oxford University Press, 1929.

VORLESUNGEN ÜBER FUNKTIONELLE PATHOLOGIE UND THERAPIE DER NIERENKRANKHEITEN. By Dr. Baron Alexander v. Koranyi. Berlin: Julius Springer, 1929.

<sup>5</sup>SURGERY OF THE LUNG AND PLEURA. By H. Morrison Davies, M.A., M.D., M.Ch. (Camb.), F.R.C.S. (Ed.). New York and London: Oxford University Press, 1930.

<sup>1</sup>CLINIQUE ET THÉRAPIQUE CHIRURGICALES. By George Pascalis. Paris: Gaston Douin & Co., 1932.

THE MECHANISM OF THE LARYNX. By V. E. Negus, M.S. (Leam). F.R.S. (Eng.). With introduction by Sir Arthur Keith. St. Louis: The C. V. Mosby Company, 1929.

surgery. The monumental *Chirurgie der Brustorgane* of Sauerbruch in German and the two volume *Thoracic Surgery* of Howard Lilenthal in English are the outstanding works. The reviewer knows of no effort, in recent years at least, to cover the field of chest surgery in a short text, which can be used for students or graduates whose time or inclination do not warrant an exhaustive study. In English many excellent monographs have appeared on certain phases of chest surgery but none on the subject as a whole. H. Morrison Davies' *Surgery of the Lung and Pleura* not only fills an empty space but fills it well. In about 300 pages he covers his subject in a clear, concise manner. The work is short but not superficial. The text is illustrated with many good X-ray reproductions and also some diagrams. The fact that the author is in reality a specialist in diseases of the chest and not a general surgeon, gives him a broad outlook over this field. This is reflected in the excellent paragraphs on diagnosis and therapeutic indications. The book contains all and more than the usual student or physician will want to know about chest surgery and has numerous references for those who want to delve deeper in the subject.

RALPH BOERNE BLITMAN

THE fifth edition of Comyns Berkeley's *Gynaecology for Nurses and Gynecological Nursing* contains not only all that is reasonable to expect a nurse to know about gynecology but considerable practical information about obstetrics. More than half of this 400 page book is used to cover anatomy, physiology, pregnancy, parturition, and diseases of the reproductive tract, while the remainder is given over to gynecological nursing. Anatomy and physiology are treated in a clear, concise manner, and the clinical significance of anatomical or physiological variations are discussed in a practical fashion. The treatment of obstetrical emergencies are considered in such a way as to suggest operative interference by the nurse. The reviewer does not believe a nurse should attempt to remove an adherent placenta. Nor do we approve of the use of hot 120 degree F intra uterine antiseptic douches for uterine hemorrhage, particularly postpartum.

Despite these minor criticisms this text is an excellent reference for nurses and supplements the lectures usually given so well that we have added it to our reference library for nurses.

SAM J. FOGELSON

THE English edition of this monograph<sup>1</sup> is well worth reading. The author first reveals the essential methods in the treatment of eclampsia, and then gives the history of his prophylactic method, describing the surroundings and conditions

under which he has been working, the history of the prophylactic methods, its results, his conception of the pathogenesis of eclampsia, and the methods of treatment. He then reports some instances of treatment which are of particular importance to practicing physicians. These instances give a closer idea of exactly what Stroganoff does.

There is very little to criticize in his presentation of the subject except that, in his endeavor to impress, he has repeated himself several times throughout the monograph. If he had not done this it would have shortened the work about twenty per cent.

The book is an excellent monograph for every physician who does obstetrics. E. L. CORNELL

THE small manual<sup>2</sup> written by Richard M. Smith to aid mothers in the care of their infants during the first 2 years is well written and, what is equally important, is concise in the information given. Suggestions as to feeding are given with the reservation that a physician should direct the feeding and that such advice is given only for those who cannot avail themselves of the services of a physician familiar with infant feeding.

The instructions as to feeding will not meet with the absolute approval of all physicians as to the age at which certain foods are given, or the kind of sugar added to the milk mixture. This, however, is a question of the individual physician and of geography and it is realized that infants will thrive under a variety of methods.

The general advice about clothing, care of a sick child, and the outlining of a day's schedule of routine duties are excellent. GERARD N. ARIST

THE reference hand book by A. James Larkin<sup>3</sup> is intended for the guidance of the general practitioner in deciding when to refer cases for radium therapy. It covers quite completely the various pathological conditions in which radium is useful as a therapeutic agent. Each disease is discussed in a fixed outline form which includes a more or less brief paragraph under pathology, radium indication and contra indication, application, reaction, and prognosis. This is followed by one or two case histories to illustrate the action of radium in the disease discussed. A short bibliography concludes each of these sections, and the appendix contains additional bibliographic references.

The book is obviously not intended for men who are experienced in the use of radium, nor is it an adequate manual of radium therapy. Those physicians, however, who confine their work to other fields but have occasional need for information regarding the value of radium therapy in a given case, will find that information concisely stated and easily available in this book.

<sup>1</sup> GYNECOLOGY FOR NURSES AND GYNECOLOGICAL NURSING. By Comyns Berkeley, A. M. D., M. Ch. (Cantab.) F.R.C.S. (Lond.) F.R.C.S. (Eng.) New York G. P. Putnam's Sons 1930.

<sup>2</sup> THE IMPROVED PROPHYLACTIC METHOD IN THE TREATMENT OF ECLAMPSIA. By Prof. W. Stroganoff. 3d ed. rev. Edinburgh E. & S. Livingstone 1930.

<sup>3</sup> THE BABY'S FIRST TWO YEARS. By Richard M. Smith, A. B. M. D. Sc. D. 3d ed. rev. Boston and New York Houghton Mifflin Company 1930.

<sup>4</sup> RADIIUM IN GENERAL PRACTICE. By A. James Larkin B. Sc. M. D. New York Paul B. Hoeber Inc. 1929.

The author's enthusiasm on the subject is quite evident in the work but it cannot be said that his claims are too extravagant

JAMES T. CASE

IN the first half of the first volume of Stoeckel's *Handbuch der Gynaekologie*, Stoeckel has undertaken a recasting and rewriting of that old German standard work Veit's *Handbuch der Gynaekologie*.<sup>1</sup> He has revamped the entire work but has retained the title partially out of respect for Veit, his old teacher and also because of the fact that the Veit *Handbuch* was for many years one of the better known German works. This work gives promise of being extensive as the first half of the first volume contains well over 700 pages. Stoeckel states specifically that in spite of the size of this work it is not to be a competitor of the even larger German work by Halban and Seitz *Biologie und Pathologie des Uterus* which has so recently appeared but rather to be a complementary work for the practicing specialist in gynecology.

The section on anatomy by Fandler is as may well be expected carefully written, profusely and

Handbuch der Gynaekologie. Edited by W. Stoeckel. Vol. I: first half. Anatomie. 165 pp. 250 mm. Anatomische Atlas. 165 pp. 250 mm. Verlag von J. F. Bergmann, München. 1924.

well illustrated, and admirably set together. One criticism may be offered—that too much space is given over to a complete list of all references from the world literature. Of the 350 pages in the section of anatomy over 100 are used for an alphabetical listing of all references. This proportion holds throughout and it impresses the reader as a waste of space and material for this type of work. Such completeness is of no value to practicing gynecologists the majority of whom have available one type or another of medical index. One interesting and comforting sidelight of this very complete bibliography is that at least in this German work cognizance is taken and due recognition is given to the American literature. This occurrence is so unusual as to deserve special comment.

The section on embryology by Spuler of Erlangen, and the one on malformations by Menge and Getlinger of Heidelberg complete the first half of the first volume. They are written in much too simple a style many facts are glossed over and apparently neglected and by contrast to the section on anatomy are inadequately illustrated. Future volumes must show improvement to rank this work with the really few standard works on gynecology in the world literature of today. RALPH A. RUS

## CORRESPONDENCE

### DR THOMAS BOND—A CORRECTION

In the *Fideler*. In the June 1924 issue of *SURGERY, GYNECOLOGY AND OBSTETRICS* you kindly published over my name a brief account of Dr. Thomas Bond a Marylander by birth who rose to distinction in Philadelphia. Accompanying the article was a copy of the portrait obtained by me from the College of Physicians of Philadelphia and this picture appears in several publications<sup>1</sup> as the likeness of the Dr. Bond to whom I was interested.

Comparatively recently Miss Helen Cadwalader of Philadelphia a descendant of Dr. Thomas Bond's brother, Dr. Phineas Bond has investigated this picture and offers proof that it is a likeness of Dr. Thomas Bond of Watertown, Massachusetts who spent his later years in Philadelphia. There is in

the possession of Dr. William Pepper of Philadelphia a miniature said to be Dr. Thomas Bond friend of Franklin and one of the founders of the Pennsylvania Hospital of whom I wrote. An interesting article by Dr. Alison Scott in the *University of Pennsylvania Medical Bulletin* January, 1906 goes into this subject and has pictures of both the Drs. Bond in this article and he is not entirely satisfied about the miniature. I note that in Morton's *History of the Pennsylvania Hospital* there is no picture of Dr. Thomas Bond though there are pictures of practically all other doctors of importance in connection with this Hospital.

I deeply regret this error which cannot now be entirely corrected but with such authorities as those mentioned, the need for investigation or verification at the time I wrote my article did not present itself. If it had the verification might have been obtained from one of the mistaken authors. WALTER D. WIE

<sup>1</sup>A CYCLOPEDIA OF AMERICAN MEDICAL BIOGRAPHY by Howard Kelly. M.D. Saunders, 1924, vol. 1, opposite page 67. The Sons of the University of Pennsylvania.





*Mary Jones*

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE DEVELOPMENT OF CANCER IN BURN SCARS

AN ANALYSIS AND REPORT OF THIRTY-FOUR CASES<sup>1</sup>

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### BIOGRAPHICAL NOTE

Jean Nicolas Marjolin was born at Ray sur Saône on December 6, 1789. He completed his preparatory education at Commercy and later studied medicine at the University of Paris. He pursued his medical course with assiduity and in 1801 won first prize as a clinical interne. His first appointment on the medical faculty was an assistantship and professorship in the department of anatomy. He received his doctorate degree in 1803. In 1812 he was an unsuccessful competitor of Dupuytren for the chair of operative medicine in the University of Paris. He became second surgeon to the Hotel Dieu of Paris in 1813 and later was surgeon to the Beaujon Hospital. In 1819 Marjolin was appointed to the chair of surgical pathology of the faculty of medicine. After 1830, he was consultant surgeon to Louis Philippe.

Marjolin was a better consultant surgeon than a practicing surgeon. Although he was a teacher of high repute, a surgeon of more than average ability, and a consultant of distinction, yet he never made any notable discoveries. His clientele was composed principally of very wealthy patients, in consequence of which he acquired a considerable fortune and abandoned surgery so that he might devote his time to horticulture. He died in Paris on March 4, 1850.

The eponym which bears his name, "Marjolin's ulcer" was derived from his lucid description of the carcinomatous ulcers, which originate on degenerating scars. In 1828, over one hundred years ago, he described these lesions in the *Dictionnaire de Médecine pratique*.

*"La surface de ces ulcères est formée par un tissu composé d'un grand nombre de sillons et de saillies, d'une texture dense, serrée très rapprochée les unes des autres, représentant en quelque sorte un velours de laine grossier. Ces ulcérations laissent suinter en petite quantité un fluide visqueux presque incolore, fétide, qui en se desséchant forme une croûte épaisse, dure, grisâtre, très adhérente. Ils sont peu douloureux ou même indolents et susceptibles de prendre une grande étendue."*

<sup>1</sup>From the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York City. Aided by a grant from the Mrs. John L. Given Fund. Read by invitation before the Surgical Section, New York Academy of Medicine, October 3, 1930.

**D**URING the twelve year period from January 1, 1917, to January 1, 1929, 1,091 patients with epidermoid carcinoma of the skin and 1,374 patients with basal cell carcinoma of the skin were treated at the Memorial Hospital. These cancers developed on the basis of burn scars: new and ancient, in 28 instances, 21 were epidermoid carcinomata and 7 were basal cell epitheliomata. From these data we have estimated that 2 per cent of all epidermoid carcinomata and 0.3 per cent of all basal cell carcinomata originate on skin subjected to thermal injuries. We are unable to determine the incidence of such cancers with relation to the number of burn scars.

### HISTORICAL NOTE

Celsus observed the development of cancer in burn scars. In 1828, Marjolin published his classical description of the ulcer which originates in degenerating scars and which is known today as "Marjolin's ulcer."

In 1839, Dupuytren related the case history of a Belgian who was treated for an enormous cancer which arose on the scar of a burn by sulphuric acid. He described the instance in his *Leçons orales de clinique chirurgicale*.

*"C'est ainsi, dit-il, qu'il y a quelques années, je fus obligé de pratiquer l'amputation de la jambe à un"*

*habitant de la Belgique pour un vaste cancer qui lui était survenu sur la cicatrice d'une brûlure profonde faite dans son jeune âge par de l'acide sulfurique répandu sur l'articulation du pied avec la jambe, le pied et la partie inférieure de la jambe. Cet individu avait pourtant passé sa jeunesse et son âge mûr sans aucune espèce d'accident. Le cancer ne se déclara sur la cicatrice actuellement tirailée qu'aux approches de la vieillesse.*

The English surgeon, Cæsar Hawkins, in 1825 reported two epitheliomata, which had developed in the scars of English soldiers, who had been burned in India, 11 and 27 years before the inception of the cancer. The French physician, Heurtaux, wrote a brochure on this subject in 1860. Broca observed an epithelioma in an ulcerated scar on a man aged 75 years, he reported this observation in 1862 and stated that the patient was burned 51 years before (1811) when he was 24 years old and a soldier in the Napoleonic wars.

The kangri burn cancers of the Kashmiris and the kairo burn cancers of the Japanese are well known examples of the influence exerted in the production of skin cancers by the repeated application of heat.

#### KANGRI BURN CANCER

Since 1881, at the Kashmir Mission Hospital India, there have been over two thousand cases of kangri burn cancer. During the last 35 years, the surgeons at this hospital have performed 45 operations annually for kangri burn cancer as compared with 10 per annum for other forms of cancer. Ernest F. Neve, senior surgeon at this institution, has written interesting and illuminating accounts of the nature of this neoplasm.

The "kangri" is an earthenware bowl 5 or 6 inches in diameter, surrounded by basket work and surmounted by a wicker handle. It is heated by means of wood charcoal, and is worn by the poorer class of Kashmiris against the skin under a single, loose garment not unlike a smock. The primary factor in the causation of kangri cancer is heat. Neve has shown by experiment that the temperature to which the skin is exposed is between 150 and 200 degrees F.

The seats of election of the growths are the inner sides of the thighs and the anterior surface of the abdomen above or below the

umbilicus. They are never found on the back or on the extensor surface of the limbs. The skin of the abdomen and thighs may exhibit every stage of chronic dermatitis from redness with or without desquamation to thickened patches, warty induration, or even horny outgrowth projecting from the surface. Pigmentation is increased over the distribution of the superficial veins, their course being marked by brown discoloration. Such patients are especially prone to develop epithelioma. The frequency of actual scars from previous burns is noteworthy. It is such a scar which usually forms the nidus of the malignant growth.

The disease is more common in men than in women, because of less continuous use of the basket by the latter. The average age of onset is 55 years. The average duration of life is 15 months from the recognized time of onset of the cancer.

There are three forms of this cancer, all of which are types of squamous cell epithelioma. The most common variety is a circular or oval crateriform ulcer having raised edges and a diameter of about 1½ inches. Another type consists of multiple small ulcerated or excavated areas with little signs of overgrowth. The third variety is a cauliflower excrescence, 3 or 4 inches wide and projecting 1 or 2 inches above the contiguous surface. There is always a septic discharge from the cancer.

More than 50 per cent of the cases, when first seen, show invasion of the regional lymph nodes, particularly the nodes in Scarpa's triangle and along Poupart's ligament when the lesions arise on the limbs. In the operation, which is fairly successful, the lymph nodes are removed first because the primary tumor is septic.

#### KAIRO BURN CANCER OF THE JAPANESE

The habit of using a portable oven for the maintenance of body warmth is also a cancer hazard among the Japanese. This utensil is a light tin box, 7 inches long, 4 inches high, and 1 inch thick, with a sliding top made of the same material. This flat box is curved on its broad surface to enable it to fit snugly against the contour of the abdomen. Within the box is placed powdered charcoal which is ignited



Fig 2 Case 1 Appearance on admission

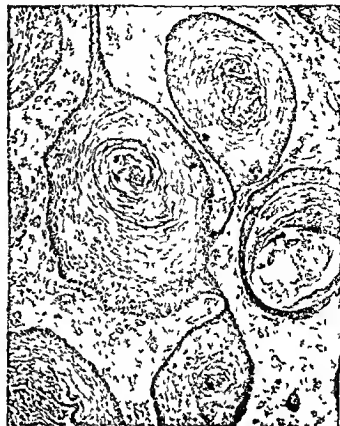


Fig 3 Case 1 Photomicrograph of squamous carcinoma, Grade II.

by sprinkling hot coals over its surface. The cloth poke or sack enveloping the tin oven is frequently heavily embroidered with designs. It is worn under the kimono and against the shirt and is held in place by a sash around the waist. Heat is generated for at least 3 hours. The kairo is worn more commonly by the older women, particularly when attending temples of worship.

Continued or prolonged exposure of the skin to artificial heat produces an erythematous burn or chronic thermal dermatitis known as *erythema ab igne* (ephelis ignealis) or fire flowers. The mechanism of production of cancer in these areas and the types of lesions are similar in every respect to these features of the kangri burn cancer.

#### THE ETIOLOGY OF BURN SCAR CANCERS EWING'S POSTULATES

To establish the relation of any cancer to a single trauma, Ewing has formulated a series of postulates which must be fulfilled in each instance. These postulates are equally applicable in the case of carcinomata developing in burn scars, namely

1 Incontrovertible evidence of the burn, as shown by the wound or the resultant scar

2 The law of localities, which purports that the cancer must originate within the boundaries of the burned area.

3 The absence of any precursory or similar neoplasm on the site of the burn prior to the development of the cancer. We have observed one case wherein a pigmented nevus was situated in the region of the burn, later a true melanoma developed in the burn scar. Another interesting occurrence was the development of a neurogenic sarcoma in a burn scar, the patient previously had generalized neuro-fibromatosis. Evidently in these two instances the thermal trauma or the disturbances attendant on infection and healing of the burned skin were sufficient to stimulate these benign neoplasms to malignant proliferation.

4 The histological variety of the cancer must be compatible with the tissues found in thermal wounds and scars, e.g., squamous cell carcinoma in the majority of instances and basal cell epithelioma occasionally in the superficial burns.





Fig 4 Case 2 Epithelioma originating in burn scar of left temple

5 The interval of time between the date of burning and the onset of the cancer must be proper, this postulate is more important for a single acute trauma than for burns, although on its basis we have classified these tumors into acute wound cancers and chronic scar cancers

#### THE CAUSE OF THE BURN

A burn is an injury inflicted on the body by a degree of heat higher than is compatible with healthy action in the part affected. A burn can be caused by any body that radiates

TABLE I—THE CAUSE OF THE BURN

Cause of burn	Acute wound cancer	Chronic scar cancer
1 Flame	1 Squamous cell 1 Basal cell	4 Squamous ca
2 Alcohol flame		1 Squamous ca
3 Hot oil or wax	1 Squamous cell 1 Basal cell	1 Squamous ca
4 Scald		5 Squamous ca
5 Hot tar		2 Squamous ca
6 Molten metal		1 Squamous ca 1 Basal cell ca
7 Powder explosion		2 Squamous ca
8 Hot objects	2 Basal cell	2 Basal cell ca
9 Unknown		3 Squamous ca



Fig 5 Case 3 Epithelioma of right temporo-frontal region

much heat. The potentiality of a scar to undergo malignant degeneration and the histological variety of epithelioma resulting are due to the extent of surface area involved and to the depth of the burn, which in turn are related to certain factors, namely (1) the degree of temperature, (2) the nature of the exciting agent, and (3) its capacity for heat absorption, (4) the duration of contact, (5) the susceptibility of the part acted upon, and (6) the condition of the patient.

Burns are commonly due to proximity to, or direct contact with, flame or heated solid bodies, superheated air, gas and powder explosions, and inflammable liquids, such as gasoline. Scalds are produced by the action of boiling water, or other liquids, superheated steam, and molten metals. The difference in the effects of burns and scalds is comparable to the distinction between roasting and boiling. The higher the temperature of the burning agent, the more severe injury will result, other conditions being equal.

The content of this report considers only thermal and chemical burns, excluding those cancers developing in skin which has been overirradiated by X rays or radium.

In general the acute wound cancers which are listed in Table I, and which developed



Fig 6 Case 5 Epithelioma of scalp originating in a burn scar

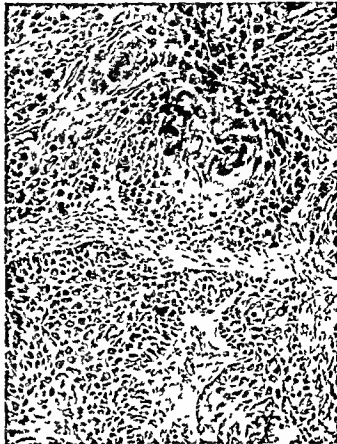


Fig 7 Case 5 Photomicrograph of squamous carcinoma, Grade II

within a year of the date of the injury, occurred in instances of quite superficial burns with little surface involvement. The one exception to this rule was in Case 23, in which a burn of moderate severity and extent caused by hot molten wax was complicated by the development of an acute wound squamous cell cancer within a year. Another generalization may be deduced from these data, all the basal cell cancers of scars occur in instances wherein the burn was sufficiently superficial to spare the hair follicles and sweat glands.

At first glance this conclusion seems to contradict our previous conceptions regarding the types of burns produced by the various agents listed in Table I. For example, hot oils were the agents in burns which terminated in two acute wound cancers and one chronic scar cancer. Fluids, such as oil, which boil at higher temperatures than water produce increasingly severe results. The thicker the fluid is, at the same temperature, the greater is its capacity for heat. Moreover, this oleaginous fluid adheres longer and evaporation being slower, the effect is naturally more

severe. Burns by hot objects (of which two were by hot cinders or coals) were the causative agents in four instances of basal cell epitheliomata. Ordinarily, as the heat of solid bodies is usually greater than that attained by liquids, except metals in a state of fusion, the former produce very deep burns, in which no vestiges of the previous epithelium and its accessory structures, the hair follicles and sweat and oil glands, remain as possible points of origin for such basal cell epitheliomata. On the contrary, fluids flowing over a large surface cause more extensive though comparatively superficial lesions, yet scalds were provocative of dense hard scars in 5 instances of this series, which resulted in squamous carcinomata at a late period. The explanation for these differences lies in the individual variations and the other factors which influence the development of cancer in scars.

The relative capacity of the substance for heat does not always determine the intensity



Fig 8 Case 6 Two epitheliomata of face originating on burn scars. Note the surrounding scars and the acquired epicanthus of the left eye

of the injury, although in many instances this is true. This apparent paradox can be explained on the assumption that some articles are not only better heat conductors than others but they cause a more decided destruction of tissue due to their tenacious surface



Fig 9 Case 7 Ulcerating squamous carcinoma of left postauricular region

adherence. This factor is evident in burns by brass (Case 28) and by hot pitch (Cases 12 and 14). In such instances the adherence to the skin involves the tearing away of the superficial portions of the derma in the removal of the burning agent. In view of the carcinogenic influence of tar, one must be cautious in attributing the cancer in the scar to the ordinary factors which induce this development. Tar cancer in the human may develop 30 years after exposure and in experimental animals at least, one application of tar has been known to be sufficient. Findlay used hot tar in his experiments with carcinogenesis which may invalidate his results in so much as the heat should be considered an accessory factor in the production of cancer.

#### THE SEX INCIDENCE OF CANCER IN BURN SCARS

Of 1,091 squamous carcinomata of the skin studied at the Memorial Hospital, 59 per cent were in males and 41 per cent were in females. Of the 21 squamous carcinomata which occurred in burn scars, 16 (76 per cent) were in males and 5 (24 per cent) were in females. Of 1,374 basal cell carcinomata of the skin studied at the Memorial Hospital, 56.5 per cent were in males and 43.5 per cent were in females. Of the 7 basal cell epitheliomata which occurred in burns or burn scars, 6 (86 per cent) were in

Fig 10 Case 9 Small epithelioma on an extensive burn scar of the back of the neck. The ears were destroyed by the burn

males and 1 (14 per cent) was in a female. These figures clearly indicate that the male has a much greater liability to develop cancer in the scars of burns than does the female, this liability moreover exceeds the usual preponderance of male over female in the case of all epitheliomata of the skin.

Few physicians realize that more females than males die of burns, particularly during childhood and old age. In the fourth year of life the relatively high death rate of females begins. The margin increases from 5 to 9 years when more than twice as many girls as boys die of this cause, and there is a more or less pronounced excess in the death rate of females until the age of 35 is reached. It is not until the age of 35 is reached, when very large numbers of men are engaged in industries subjecting them to the hazard of burns and scalds that so many males die from this cause as do females. In later life when fewer men are subject to these risks, women again experience a much higher death rate. Female attire is an important factor in increasing the hazard.

The greater frequency of burns and scalds in females and the infrequency of cancer in the scars of such burns, do not disturb the etiological significance of thermal trauma to scar cancer, although many of these cancers develop in scars of burns which occurred in childhood, when more girls than boys are burned. If the scars of burns are more com-



Fig 11 Case 9 Photomicrograph of squamous carcinoma, Grade II

mon in females than in males, then the reason for the preponderance of males who develop cancer in their scars can be found in the more frequent irritation, infection, trauma, and neglect of these scars.

#### AGE AT ONSET OF CANCER

The average age of 1,091 patients with squamous carcinoma studied in this institution was 58 years, only 7 (0.64 per cent) of these patients were younger than 25 years. The average age of 1,374 patients with basal cell carcinoma studied in this institution was 61 years, only 7 (0.5 per cent) of these patients were younger than 25 years. Of the cancers developing in burn scars and unhealed burns, the chronic scar cancers occurred at the average age of 53.5 years, and the acute wound cancers at the average age of 56 years. The age of the scar is more important than the age of the individual, because this variety of cancer may occur in young people if the scar has been existent for a long time, such as from infancy or childhood. One of the patients in our series (Case 16) was burned at the age of 3½ years and had a squamous cell carcinoma



Fig. 12. Case 10. Ulcerating squamous carcinoma of dorsum of hand and fingers.

develop in the scar 14 years later. In the early report by Hawkins, one of his 2 patients was only 28 years of age. DaCosta reported the occurrence of an enormous squamous carcinoma in a burn scar involving the entire lumbodorsal region of a man aged only 20 years. The average age of the patients with

TABLE II—AGE INCIDENCE

	Memorial Hospital 85 cases	Other authors 45 cases
A. Age on admission Chronic scar cancer Acute wound cancer	57.2 years 55.0 years	47.5 years 55.0 years
B. Age when burned Chronic scar cancer Acute wound cancer	19.0 years 51.0 years	17.6 years 54.5 years
C. Time interval between burn and onset of cancer Chronic scar cancer Acute wound cancer	57.5 years 0.3 years	30.6 years 0.6 years
D. Chronic scar cancers—number Squamous cell type $\sigma^2=14$ $\eta=5$ Basal cell type	23 19 3	30 Almost all No recorded instance
E. Acute wound cancers—number Squamous cell type $\sigma^2=2$ $\eta=0$ Basal cell type $\sigma^2=3$ $\eta=1$	6 2 4	6 3 4
F. Time interval between appearance of tumor and admission to clinic Chronic scar cancer Acute wound cancer	37 years 2 years	
G. Actual total time from onset of cancer until death or present date (3-20-30) Chronic scar cancer Dead (8) Living (13)  Lost track of (1) Acute wound cancer Dead (1) Living (5)	3.4 years average 0.5 years average Instances 36 3 4 4 5 5 6 7 15 16 17 18 19 20 years  1 year 5.7 years average Instances 2 4 5 6 8 9 years	



Fig. 13. Case 10. Photomicrograph of squamous carcinoma, Grade II.

carcinomata arising in burn scars and reported by Mason was 51.5 years. The average age or duration of the scars in these same people was 42 years, therefore he concluded that the majority of the burns occurred in childhood.

#### THE SCAR

*Time consumed in healing of wound.* In the 6 cases of acute wound cancer, the carcinomata made their recognizable appearance before healing was complete. We have incomplete data concerning the healing of burns which later developed scar cancers, in 9 instances the healing time was ascertained. In 3 of these instances the wound never healed, one developed cancer in 5½ years after the burn (Case 12) and the 2 other patients developed cancer at indefinite periods after the burns. The average time consumed in healing for the 6 other burns was 805 days. Not one burn of these 28 was treated by skin grafting; healing took place by the natural processes of epithelialization from the margins of the wounds and from residual hair follicles and sweat glands when present. Under normal circumstances, this epithelium grows slowly at



Fig 14 Case 12 Epithelioma of dorsum of right hand

the average rate of one-eighth of an inch a week, so if the area of skin lost was of considerable extent, healing would be laborious and tedious. Moreover, infection by pyogenic organisms, a constant concomitant of ungrafted burns, delays the healing process and contributes greatly to the production of dense, fibrotic, avascular scar tissue. Syphilis and anaemia are other factors which interfere with wound healing. Scars of slow formation are much more liable to undergo carcinomatous degeneration than scars quickly formed, as the latter are pliable and soft. The location of the burn sometimes impedes rapid healing, particularly when the axilla, groin, and middle of the back are involved.

*Duration of scar before the onset of cancer* It has been stated previously that these forms of cancer can be divided into two separate groups on the basis of time relationship to the development of cancer. The interval between the date of injury and the onset of the cancer was only 0.3 years for the acute wound cancers, whereas in the chronic scar cancers the average age of the scars was 32.5 years. The



Fig 15 Case 13 Epithelioma originating in burn scar of elbow



Fig 16 Case 14 Epithelioma originating on a burn scar of the right forearm

available data at hand indicate that the patients with chronic scar cancers were burned at the average age of 20 years.

The acute wound cancers of burns are more frequent in older people with atrophic and keratotic skin, the average age of these patients when burned was 52 years. In such instances the thermal trauma is a probable exciting factor to a skin which is already more susceptible to carcinogenic influences, whereas in old scars the cancers are the result of other metagenetic changes and the heat *per se* has no direct bearing on the genesis of the cancers. If heat is not the causative agent in the acute wound cancers of burns, there is the question of possible stimulation by the tissue toxins released by autolysis and heterolysis from the burn eschar, the absorption of these toxins leads to parenchymatous degeneration of the viscera and proliferation of connective tissue. An interesting possibility is presented in a case report by Eichorst, a carcinoma developed in the edge of a duodenal ulcer after burning and metastasized to a dorsal vertebra. This so-called duodenal ulcer of Curling is an occasional complication of extensive burns and its mode of origin is disputed. It is presumably



Fig 17 Case 15 Photomicrograph of squamous carcinoma Grade II

caused by the excretion of acrid toxins in the bile or by septic embolism in the duodenal wall. Carcinoma of the duodenum is rare and ulcer of the duodenum is common. The toxins resulting from the burn may have had some part in the cancerous transformation of this ulcer in Eichorst's patient.

Acute cancers in burns seem to be infrequent, Stauffer, Bang, Huguenin, and Pickering have reported cases in point, the cancers appearing within thirty days following the burns.

*Relation of the scar to the development of cancer.* Scar cancer has been designated by the French as "carcinoma epitheliale cicatriciels." Innumerable cases have been recorded in the literature of carcinoma developing in lupus scars, in scars of sinuses, in scars communicating with necrotic bone as in osteomyelitis, in scars of amputation stumps, in scars of X ray burns, in scars of animal and insect bites, in vesicovaginal fistula and fistula *in ano*, and even in the scars of operative incisions, although Delbet states that carcinoma never develops in scars of wounds which heal by primary intention. Some oesophageal cancers follow scalds or caustic burns of this viscus (Grandclaude). Among



Fig 18 Case 16 Photomicrograph of an epidermoid carcinoma which metastasized to the left scapula and right lung

the epitheliomata treated at the Memorial Hospital were 2 squamous carcinomata which developed on scars of a frostbite and of a carbuncle. In Mason's series of 98 scar cancers, 19 were in scars produced by burns. Baasner stated that in 190 collected cases of scar cancer, 33 followed burns, 48 were in fistulas, 39 in leg ulcers, 14 in lupus scars, 12 on calluses, 31 on cicatrices produced by various traumata, and 13 were of miscellaneous origin. Durand collected 90 cases of degenerated scars and noted that 70 of this group were in burn scars. Montpellier and Fabiani comment on the infrequency of epithelioma of the skin and the converse frequency of burns in childhood in the natives of Algiers, they attach an etiological significance to the fact that the 5 cases of cancer of the skin which they report, were epitheliomata which developed on the basis of burn scars.

Bang succeeded in producing experimental scar cancers in 2 mice which had been severely

burned In 1 mouse, the carcinoma appeared within 4 weeks after the burning In the other mouse, a papilloma developed in the scar, 1 year and 5 months after burning, this lesion later changed to a true papillary squamous carcinoma

Goldblatt classifies burns into two classes according to their end-results those that will heal with scar formation, and those that will heal without scar formation This method immediately puts into the mind of the surgeon a practical classification in which the expected functional end-result is predominant Thus under this classification Goldblatt recognizes a type 1 or scar forming, and a type 2 or non-scar forming burn This classification also, in terms of treatment, tells the surgeon that a type 1 burn will require special treatment to minimize scarring, whereas a type 2 burn will require no thought to the possibility of scar formation and will necessitate no treatment except to relieve the inflammation Type 1 burn is the only one of significant import in the study of scar cancer

On the basis of Dupuytren's classification of burn depth, burns of the first degree are not attended by scarring, burns of the second degree produce slight pitting only when the blisters or bullæ injure the stratum germinativum, burns of the third degree produce superficial scars which are not liable to appreciable contraction, and burns of the fourth or fifth degrees tend to cause severe contractural deformities and dense thick scars after healing has occurred The cicatrices may be small and flat or large and rugous The neighboring skin may be soft and pliable as in the normal state, or tightly stretched to produce cosmetic disfigurement or contractural deformity The tight, thick, dense scar is the one most liable to carcinomatous degeneration Clement, on the contrary, has stated that cancer usually develops on scars of burns of the second or third degree (Dupuytren), in which the skin destruction is not deep We find the acute cancer of burns, particularly the basal cell type, to originate usually on wounds of this superficial character

The unique difference of burn scars from the scars of other wounds is that the scar is spread out on the surface and is entirely visible,



Fig. 19 Case 17 Recurrent nodule of epidermoid carcinoma in center of wound of popliteal space

whereas scars of incisions, punctures, lacerations, etc., are distributed in the depths of the tissues The process of repair is essentially the same in the two types of wounds, but in the case of burns, the amount of epithelial regeneration is undoubtedly greater

The scar tissue resulting from a burn undergoes greater contraction than new tissue formed in other circumstances The tendency of such a scar to contraction continues for many weeks after the completion of cicatrization Contraction proceeds slowly, painlessly, imperceptibly but irresistibly As a consequence, the cicatrix puckers the neighboring integument into folds, the scar itself grows thicker and develops irregular knobs or tubercles within its substance This type of indelible cicatricial tissue is called "inodulaire" by French surgeons and is prone to ulcerate The amount of scar tissue depends not only on the depth and extent of the burn, but also on the variable susceptibilities of the patients We emphasize the contractures and tension of scars because it is in such conditions that ulceration is easily provoked

The diseases of the burn cicatrix are fissures, ulceration, irritability, itching, neuralgia, hypertrophy, and keloidal, epitheliomatous, and calcareous degenerations The scar is less highly organized than the original integument and as a result is peculiarly liable to ulceration and other degenerative conditions This conforms to the general law that newly formed and lowly organized structures are much more prone to inflammation and other degenerative processes than are the older and more highly constituted tissues Virchow, in his treatise on the pathology of tumors, remarked that





Fig. 20. Case 18. Enormous squamous carcinoma originating on a burn scar of the left leg

cicatrices may be the starting points for certain of the squamous carcinomata. The cicatrix, he wrote, is an incomplete structure and does not reproduce exactly the typical structure of the injured part, an instance where an imperfection of tissue exists as a contributory cause to the development of a tumor.

There is an abnormal relation between the epithelial and connective tissues in every cicatrix which establishes a predisposition to cancer formation in those scars which are accompanied by rhagades, ulcers, fistulas, and similar chronic lesions.

*Factors acting on the scar.* Scagliola asserted that 10 per cent of his patients had parents who had cancer. He suggested that a hereditary predisposition to the formation of poor scars and even scar cancer might exist. We have no evidence to confirm this opinion. The fact that carcinoma develops in tissue non-existent at birth sufficiently disproves Cohnheim's theory of embryonal rests and supports Virchow's theory of the irritative origin of scar



Fig. 21. Case 19. Large fungating infected squamous carcinoma involving the right buttock, femoral trigone, thigh, inguinal region, and mons veneris.

cancer. There is nothing in the history of scar carcinoma to give any grounds for upsetting the generally accepted theory of the histogenesis of epitheliomata. To Baasner, it seemed probable that the scars which are very slow to heal, afford portals of entry for the causative agent, which can be inoculated only with difficulty, but finds an especially favorable soil for growth in the thin cicatricial epithelium which has been injured in its nutritional relations. Such a theory is supported only by the personal opinion of Baasner.

Scar tissue is poorly vascularized because dense fibrosis obliterates many of the blood vessels, the resultant imperfect nutrition of the scar is responsible for the ease with which ulceration occurs. The dry, thin, and delicate epithelium covering the scar is easily destroyed by trauma, to which it is frequently subjected because of the elevation of the scar. The normal skin is not so readily injured by trauma because it is elastic and because of its ability to glide slightly over the subcutaneous tissues, thereby avoiding the full brunt of a blow. In the case of adherent scars, this protective mechanism is lost and the epithelium is abraded by relatively slight injuries. Each successive abrasion, ulceration, or fissure heals with increased difficulty, the quality of the regenerated epithelium is progressively inferior,



Fig 22. Case 27. Epithelioma having some of the histological characteristics of a basal cell lesion



Fig 23. Case 23. Photomicrograph of a squamous carcinoma, Grade I plus, radioresistant

and finally the persistent stimulation to the marginal epithelium for repeated growth and repair with constant frustration, may lead to a loss of tissue restraint and eventually cancer

The development of carcinoma on a cicatrix can be attributed occasionally to the trauma induced by movements of a limb or joint on which the scar is placed. Persistent pruritus in a scar is a dangerous complication because the patient invariably scratches the area and rubs off flakes of keratinized epithelium, leaving small sanguinous points which may coalesce to form an ulcer or may become infected. Acute and chronic traumas, irritation by dirt and clothing, and infection of the scar are the common stimuli to the development of carcinoma in these scars. Prolonged primary or secondary suppuration in the scar is a frequent causative antecedent of carcinoma in this location. In two of our patients (Cases 14 and 28) the stimuli to ulceration of the scars with failure to heal and finally the develop-

ment of carcinomata, were subsequent burns of the original burn scars

#### DISTRIBUTION OF THE SCAR CANCERS

The site of predilection for carcinomata of burn scars are naturally those parts of the head and extremities which are most subject to burns. Is the burn a contributory agent to the creation of a cancer by the production of a scar, or would a cancer have developed in this location anyway? Do the identical locations of these scars and cancers have a causal relationship or is it merely coincidental? These questions probably have been answered correctly by Galard, as follows

*"Certaines conditions traumatiques et en particulier les cicatrices de brûlures sont apparaitre les épithéliomes vulgaires à un âge et dans des régions, où l'on n'a guère l'occasion de les rencontrer d'habitude"*

In our own experience, we have observed that many of these scar cancers begin in regions where the ordinary epitheliomata of the skin are quite infrequent, as on the arm,



Fig. 24 Case 24 Epithelioma originating in a burn scar of the dorsum of the hand

elbow, groin, and popliteal space (Cases 13, 14, 16, 17, 19, 20)

Ruchaud lists the distribution of these scar cancers in the order of their frequency as follows arm, leg, head, and trunk. He found the upper arm affected more often than the forearm and the thigh more often than the leg. The distribution of the 28 cancers in our group is shown in Table III, which can be summarized as follows, head, 10, including 4 of the 6 acute wound cancers, hand, 5, neck, 3, thigh, 3, arm, 2, back, 2, leg, 1, foot, 1, knee, 1. All 5 carcinomata of the hand were situated on the dorsum of this member. The palm of the hand is frequently subjected to superficial contact burns, seldom causing more than vesication, furthermore palmar burns heal quickly and produce minimal scarring. On the contrary, the dorsum of the hand suffers more severe burns and scalds, the skin texture is of poorer quality and does not heal so readily as the palm, the circulation to the dorsum of the hand is inferior to that of the palm, sharp traumas to scars are more frequent on the dorsum and the metacarpal bones are quite close to the scar. Three of the 5 cancers involved the right hand, the right hand is burned more often than the left and the scars of this location are undoubtedly traumatized more frequently than are similar scars on the left hand. Conversely the left hands of roentgenologists are burned by roentgen rays and roentgen ray ulcers and cancers are usually on the dorsum of the left hand.

#### PATHOLOGICAL ANATOMY

*Gross pathological anatomy* Cancers developing in burn scars are often multiple if extensive cicatrization exists (Cases 5 and 18)

In form they are early distinguished from other epidermoid carcinomata of the skin by the fact that they originate only in the investing epithelium. The carcinomatous degeneration, especially in large ulcers, is often confined to the margins, which begin to crenate and show a warty appearance. There are two clinical forms of this cancer, (1) the flat, indurated, infiltrative, ulcerative carcinomata, and (2) the exophytic, evrcent, vegetative, papillary carcinomata. The majority of these neoplasms are the ulcerative variety, the papillary form is infrequent. The papillary carcinomata are often movable and not attached to the deep structures as are the ulcerative carcinomata. The two typical papillary epidermoid carcinomata in this report are Cases 3 and 13. The infiltrating carcinomata invade not only the surrounding scar but also muscles, tendons, and bones (Cases 5, 7, 10, 12, 14, 15, 16, 18, 19, 20). Deep invasion is late and the spread of the tumor by direct growth is often determined by the deep fascial planes. All of the bulky scar cancers are malodorous due to sphacelus and saprophytic infection.

The basal cell epitheliomata arising in superficial scars are small at first and differ in no way from the usual clinical picture of rodent ulcer or of adenoid cystic epithelioma.

*Pathological histology* Histologically also, the ulcerative variety is more common than the papillary epitheliomata, furthermore, it is clinically and histologically a more malignant cancer, an assertion which is substantiated by earlier metastases from this sort of lesion. If the burn is deep enough to destroy the corium, then squamous carcinoma is the only histological kind of epithelioma which could originate on the resultant scar, because the hair follicles, sweat glands, and skin accessories *in toto* would be likewise destroyed and the only epithelial structure left would be the epidermis.

By grading these cancers according to malignancy, we found all the epidermoid carcinomata to be squamous cancers, Grades I and II, well differentiated, radioresistant, adult neoplasms. The typical products of keratinization of these carcinomata consist of sterile squamous sheets, where the protoplasm is

changed to keratin or to a substance analogous to keratin. These sheets are end products, they are deprived of nuclei, sometimes this substance is encysted or sequestered in the tissue depths as cornified globules or "pearls." Intercellular fibrils are sometimes visible, mitoses are observed, foreign body giant cells may be present near the globules of keratin. When the bone is invaded, tiny spicules of destroyed bone may be found in the center of the epithelial pearls.

Inflammatory phenomena are present in variable degrees in all these cancers. Lymphocytes prevail around the early lesions, but are obscured later by the polynuclear leukocytes which accompany the inevitable infection. Ewing has tersely stated the rôle infection plays in these chronic ulcerated cancers. "Secondary infection by streptococcus is nearly constant with deep ulcers, may accompany the metastases, greatly influence the course and termination, or may even dominate the clinical picture."

The connective scar tissue forms a protective barrier against dissemination of this kind of cancer. When metastases do occur, they are histologically similar to the primary cancer, hornification, and cysts containing exfoliated scales of keratin being present.

### METASTASIS

Even when the cancer is of long duration and infiltrates deeply to the bone, the regional lymph nodes are remarkably free from metastases. The time interval between the appearance of the tumor and admission to the clinic of the Memorial Hospital averages 3.7 years for the chronic scar cancers, yet only 5 of these patients had or later developed metastases to the regional lymph nodes (Cases 3, 7, 10, 16, 22). The slow growth and the lateness of dissemination are due to two peculiarities of these cancers, the adult differentiated neoplasms and the character of the environment in a bed of scar tissue. Scar cancer of the dorsum of the hand is especially tardy in metastasizing. Metastasis is by the lymphatics, and the growing edge of the carcinoma must penetrate the barrier of fibrosis presented by the scar before the lymphatic vessels are accessible. The lymphatics

in the immediate neighborhood of the scar are largely obliterated by the cicatrix. We believe the propensities of these tumors to grow and metastasize are the same as for other squamous carcinomata of the same histological grade, once these scar cancers get beyond the limits of the enveloping scars, e.g., into muscle which is well vascularized, they will spread as rapidly as any other epidermoid carcinoma.

Squamous carcinoma of any location seldom metastasizes beyond the regional lymph nodes forming the drainage basin for the area affected. Visceral metastases are even more rare, yet they have been reported as occurring from scar cancer by Charcot, Boegehold, Gaucher, Mohr, and Durand. Boegehold's patient had a metastasis to the liver from a primary scar cancer located on the right arm, while Durand's patient, having a carcinoma situated in a burn cicatrix on the knee, disseminated to the iliac, pelvic, and lumbar lymph nodes and to the liver. Mohr reported an instance wherein a squamous carcinoma, developing in a burn scar of the right arm, caused death by histologically verified metastases to the pleura, lungs, heart, and kidneys. In this case he favored the assumption that the long, preceding pre-operative suppuration with its accompanying loss of body fluids, together with infection of the stump and post-operative hemorrhages, rendered the body incapable of withstanding the colonization of the displaced cancer cells and favored the growth of metastases. The only example of visceral metastasis in our group was in our youngest patient (Case 16) aged 19 years, who developed pulmonary metastasis from a squamous scar cancer of the knee.

### SYMPTOMATOLOGY MODE OF ONSET

We have already explained our classification of these neoplasms into two groups on the basis of time of onset: (1) the acute cancer of wounds and (2) the latent cancer of scars. The origin of the latter carcinoma is insidious. We have found that the latent cancers of scars begin in one of five different ways.

1. A small indurated itchy papule appears, which is intimately incorporated in the scar

from which it can not be definitely demarcated. This constitutes the pre ulcerative stage. The epidermis may be warty, or delicate, dry, and parchment-like, or elevated in grayish red papillæ, which are sufficiently translucent to show the dilated capillaries in their depths and periphery. In the early stages these nodules may be simple epithelial papillomata, which later become carcinomatous. The greater number, however, are cancer *de novo*. The nodules become humid, increase in size, and ulcerate, after which growth is accelerated by infection (Cases 12 and 22).

2. A diffuse tumefaction of an hypertrophied cicatrix or keloid occurs and becomes quite painful. An ulcer develops and spreads with some rapidity. Sometimes the ulcer is carcinomatous from its inception, but in many instances it is first a simple ulcer which later develops an epithelioma on its margin. This tumor enlarges to include eventually the entire ulcer (Cases 10, 16, and 18).

3. The scar usually loses its integrity before it becomes cancerous. Squamous, scaly, pruritic little plaques appear which are scratched off leaving tiny sanguineous excoriations. These fuse, resulting in an ulcer caused by a solution of continuity in the scar (Cases 3, 5, and 19).

4. Over scarred joints, indolent fissures may form, which heal reform, rebel, and finally remain open with firm, resistant, fungoid or infected bases on which the epithelioma develops (Case 17).

5. The onset of certain of these epitheliomata is by the accidental opening of the scar by trauma. The resultant traumatic ulcer does not heal because of infection and ischæmia. Carcinoma then supervenes (Case 14).

**Symptoms.** The development of latent cancers in scars is nearly always preceded by marked itching or hyperæsthesia. Functional symptoms are less important than the local manifestations. With the occurrence of an adherent ulcer, a burning sensation begins which may progress to scalding, darting pain. Because of the tenacious infection, the discharge is profuse, ichorous, and foul. Hemorrhage is not common but may be extremely severe when the carcinomatous ulcer is situated over large vascular channels in the popliteal

space, cubitus, and femoral trigone. The invasion of muscles and tendons leads to great functional disability in the later stages. In advanced cases with large suppurating necrotic lesions, toxæmia may result from absorption.

**Course.** Due to anæmia and environment, the latent cancers of scars follow an unusually slow course as compared with skin cancers arising *de novo*. Those cancers situated on the dorsum of the hand seem to run an especially slow course. Recurrences are usually local. The patient ordinarily remains in good health, until late in the course of the disease when he may be weakened by suppuration, anæmia, or infrequently metastases.

### DIAGNOSIS

The characteristic picture of a latent scar cancer is that of a chronic, resistant, indolent ulceration. It slowly enlarges in circumference and increases in depth, presenting glistening, indurated, everted edges. The other varieties are more readily diagnosed. Simple non malignant ulcers tend to heal spontaneously from time to time. Tuberculous ulcers are rare and occur chiefly in young people; they lack the local qualities of carcinoma, they usually accompany lupus, pulmonary or lymphatic tuberculosis, an acid fast stain for tubercle bacilli or a biopsy establishes the diagnosis. Tuberculous ulcers are more frequently multiple. Lapeyre reported an unusual instance of tuberculosis and squamous carcinoma co-existent in an ulcer arising on an old burn scar. Syphilitic ulcers tend to perforate or penetrate, they have a distinct purplish copper color, they are usually tertiary lesions and respond to specific test therapy, the Wassermann test and a biopsy ordinarily confirm the clinical diagnosis. In some of the ulcerated squamous carcinomata, careful expression causes an extrusion of caseous material resembling comedoes. The early recognition of cancer is imperative in order to effect a cure without mutilating operation, furthermore a correct diagnosis insures proper early treatment.

### PROGNOSIS

Despite the slow progress, the absence of disturbing symptoms and the lateness of regional metastases, the prognosis is serious.

TABLE III—DISTRIBUTION OF CANCERS

Location	Chronic scar cancer						Acute wound cancer							
	Living				Dead		Living				Dead			
	No	Irradiation	Surgery	Present status	Duration of cure	No	Irradiation	Surgery	No	Irradiation	Surgery	No	Irradiation	Surgery
Scalp						1	+	0						
Eyelid	1	+	0	No evidence	5 yr				1	+	0	No evidence		
Cheek	1	+	0	No evidence	2 5 yr				A	+	0	No evidence	2 yr	
									B	+	0	No evidence	4 yr	
Nose	1	+	+	No evidence	1 yr									
Temple	1	+	+	No evidence	3 5 yr	1	+	+	1	+	0	No evidence	4 yr	
Neck	A	+	+	No evidence	2 yr	1	+	+						
	B	+	0	No evidence	0 5 yr									
Arm	A	+	+	No evidence	4 yr									
	B	+	+	No evidence	1 yr									
Dorsum of hand	A	+	+	No evidence TB	3 yr	1	+	+	1	+	+	No evidence New cancer on lip	7 5 yr	1 Died mon-ber
	B	0	+	No evidence New cancer on face	16 yr									1 of ar-ty cul- tis
Back	1	+	0	No evidence	3 yr	1	+	0						
Thigh	1	0	Zn Cl <sub>2</sub> paste	Cancer present		A	0	+						
						B	+	0						
Knee						1	0	+						
Leg	1	0	+	No evidence	3 yr									
Foot	1	+	+	?	? lost									

Figures indicate sequence of treatments

Scar cancers which are located on the face and head are more serious than similar neoplasms on the extremities, because in the latter instance amputation may effect a cure as a last resort. For the scar cancers of the head and face the physician must rely only on irradiation and local excision. The presence of metastases in the regional lymph nodes is the most important prognostic factor, it is of far greater import than the duration of the cancer. The prognosis varies with the selection of operative treatments and the kinds of manipulative measures attempted. The prognosis is modified by the location of the tumor, its fixity, its proximity to blood vessels, the degree of sup-puration, and the radiosensitivity. The age of the patient has an influence on the outcome, older people are less tolerant of radical surgical measures, whereas in younger subjects, the

epithelioma frequently has greater growth propensities (Case 16)

In Table III, we have summarized the end-results of the cases which have been observed at the Memorial Hospital. Thirteen of the patients with latent scar cancer are living and all but one seem to be free of the disease, 7 (54 per cent) of these patients have been clinically free of cancer for more than 3 years. Eight of the patients who had latent scar cancer are dead, 1 has been lost to further observation. Of the patients with acute wound cancers, 1 died of pulmonary tuberculosis, the 5 remaining subjects are alive and clinically free of disease for an average time of 4½ years after the completion of treatment.

The ultimate prognosis for acute wound cancers is better than for chronic scar cancers although the conditions attending the former

type are more favorable for rapid growth and dissemination of the cancer. The better prognosis of acute wound cancers can be attributed to the superficial character of the average scars in our cases, the small size of the cancers, and the predominance of basal cell types.

#### TREATMENT PROPHYLAXIS

There are 6 cardinal points to be emphasized about the prevention of scar cancer in burns: (1) The prevention of the burn, (2) the local treatment of the burn, particularly the successful management of infections, (3) promotion of rapid epithelization, (4) early skin grafting of the burned area, (5) the proper care of the burn scar, and (6) radical excision of the scar at the first indication of degenerative changes: neoplastic, or otherwise.

In so much as the Memorial Hospital is an institution for the treatment of neoplastic diseases, we have little opportunity to institute methods of prophylaxis of cancer in burn scars. The prevention of burns is a subject in itself and has been considered in detail by one of us (G. T. P.) in a recent monograph on burns. A burn has been aptly defined as an infected wound produced by heat. Hence the immediate local treatment of the burn is of paramount importance in avoiding this frequent infection and establishing a granulation bed suitable for skin grafting. Suppuration of the burned area delays healing, stimulates fibrosis, and is instrumental in the production of a thick, resistant scar, the very type which is prone to develop cancer. Suppuration hastens the onset of cancer as the wound healing alternately progresses and is retarded, an unnatural and dangerous stimulation to epithelial proliferation.

In burns of severe degrees, early skin grafting is the most efficient preventive measure for thickened scars, contractural deformities, and cosmetic disfigurements. When skin grafting is delayed, there is formed an unhealthy anæmic granulation tissue, with a scar tissue base. Chronic granulation tissue is the parent of scar tissue. Nature tends to effect a spontaneous cure, but normal epithelization is too slow and should be supplemented by skin grafting. A cancer seldom if ever arises in a

scar healed by primary intention, primary wound healing is impossible in burns, but one can approach this condition by early skin grafting. It is very important to employ skin grafting in children, not only for cosmetic betterment and to prevent contractural deformities, but because scars in children are particularly exuberant and hypertrophic and therefore more prone to degenerate later in life. The scar does not grow with the child, consequently, with age it is subjected to increased tension. The existence of the scar from childhood to old age results in prolonged exposure of the scar to carcinogenic influences. None of the 28 patients included in this study had their burns treated by skin grafting. Today, the frequent use of skin grafting by many surgeons who treat a considerable number of burns, will furnish interesting information 20 or 30 years in the future, about the comparative freedom of these grafted wounds from scar cancer.

The thin ribbon Ollier-Thiersch grafts should not be used unless the extent of the burn precludes the employment of whole thickness grafts. The Thiersch grafts do not simulate normal skin, none of the skin accessories, such as hair follicles, sweat and oil glands are present, in consequence of which the grafted area is dry, without oil, and subject to the same degenerations as scar tissue. Cancer has been known to originate on Thiersch grafted regions. Lyle advocates the occasional employment of Thiersch grafts initially to close the wound, followed after an appropriate interval by full thickness grafts to the same region. If the burn is small and unexposed to view, pinch grafts of the Reverdin or Davis type are sometimes suitable. Burns of the dorsum of the hand are grafted by abdominal bridge grafts or pocket grafts along the lateral aspects of the corresponding thigh.

Every effort should be made to obtain pliable scars over joints, because the flexion and extension of these members tend to provoke ulcers and fissures in tight adherent scars. Therefore, when scar tissue is beginning to form and the burned surface overlies a joint, it is desirable to place the limb in such a position that the motion and integrity of the joint shall not be interfered with by the contraction

of the resulting scar. In a very sick patient, rest and sleep may be so essential that the surgeon should offer comfort even at the expense of this desirable attainment. The position decided upon for each limb should be maintained constantly by the application of light, removable plaster-of-paris splints. The splint should be applied immediately after separation of the eschar and during the healing of the skin graft, it should be fenestrated to facilitate dressings. The splint aids healing, maintains the full extension of the joint, prevents contracture, obviates later undue tension on the scar, insures better movability of the joint, and to some extent eradicates those factors which might lead to degeneration of the scar with ultimate cancer formation.

If the burn, though extensive, has healed spontaneously without the interpolation of skin grafts, the new fresh scar should be treated with this same idea in mind. Splints, adhesive plaster, elastic bands, and extension appliances to prevent contraction should be continuously applied. A hard contracted cicatrix often yields to gentle but constant traction without tearing. If the pressure and traction are continuous, and never violent, supple scars may form and the parts return to almost normal function. New epithelial layers may be ruptured by this method but the results nevertheless are justifiable. The scar can be softened and made more elastic by the continuous application of moist warm packs for a long time. The moisture supplied by boric acid solution must be constant and can be employed concurrently with the exercise of traction. Certain measures, such as diathermy, ionization, and emollient embrocations may be used to reduce fibrosis. Massage is advocated at the earliest moment to restore pliability of the part. Adherent scars are sometimes spontaneously liberated, but they should be aided by massage and hydrotherapeutic measures. In some instances direct pressure by vulcanized india rubber molds to the scar area will be of considerable benefit.

If the scarred skin is tense, poorly nourished, and inclined to ulcerate at the slightest provocation, improvement may be obtained by incisions made at right angles to the direction in which relaxation of the skin is desired.

Such incisions, if multiple, should be made parallel to one another and should run in the direction of the chief blood vessels, in order to spare the vascular supply of the scarred area. Some wounds gape 2 or 3 inches in width as a result of this procedure but the defect can be closed later by skin grafting. The original scar quickly assumes a more normal appearance.

All large scars are menaces. All sources of irritation should be avoided. The scar should be treated with a bland oil at times to prevent excessive keratin accumulation. If the scar becomes intractably pruritic, fissured, or ulcerated, or begins to enlarge at a late stage in its history, it is a better plan to excise such a scar before an actual epithelioma develops. Plastic treatment of a scar should seldom be started until the scar has ceased contracting. This is an end point which is difficult to determine and frequently is not reached until a year or more has elapsed since the incurrence of the injury.

The defect following excision of the scar must be filled with a skin graft. For the hand the abdominal bridge graft or the pocket graft of the thigh is suitable. Skin flaps give better results than interpolated grafts of the Wolfe-Krause type because they have a better blood supply, are less inclined to shrink, and attach themselves more readily to wounds having a scarred base. The sliding flap can seldom be used for this purpose. The transposed flap with the base of the flap at the defect is of service in covering defects on the trunk. Doctor Burton J. Lee, of the Memorial Hospital, has devised a sliding flap to cover axillary defects resulting from the excision of skin in which there was marked degeneration due to irradiation by X-rays or radium. On the head and extremities, we favor the use of pedicled flaps obtained from a neighboring site, if the skin there is available and uninjured by the burn. Otherwise the flap may be transferred as intermittent "jumps" with the forearm as temporary host to the graft. The pedicled flap is thicker than the Wolfe-Krause graft, contains more subcutaneous tissue, and is more viable. One may employ Blair's method, carefully preparing the skin flap, lifting it from its original bed, and then *colle facie* by suturing it back again for several days. This



augments the blood supply to the flap and increases the safety of its transfer to the new location. Such delayed transplantation increases the vitality of very thin or long pedicled flaps and should be used as a preliminary measure whenever possible. The application of gentle traction and the discriminate recreation of the skin incisions will generally suffice to release the flap for its transfer.

Before any flap is cut, the blood supply to the area should be thoroughly studied in order to insure an adequate distribution of blood through the pedicle to the flap proper. It is well to remember that skin in the immediate proximity to the burn may be so injured, that its blood supply is impaired to such a degree as to jeopardize the integrity of any flap which might be taken from it. The tubing of pedicled flaps is valuable for three reasons: it improves the vascularity of the flap, by lessening the amount of raw surface exposed, it diminishes the risk of infection, and it renders distal skin available. The flap should be anchored by subcuticular catgut sutures to relieve tension on the skin sutures. Dermal sutures should be for coaptation and not for forceful approximation. No definite time for severance of the pedicle can be advised for all pedicled flaps. Each requires individual surgical judgment. After a period of 6 months following the operation a limited amount of protopathic sensibility can be elicited in the transferred skin, this improves slightly up to 1 year and then becomes stationary.

#### SURGICAL TREATMENT

Very small epitheliomata may be treated by radium or if this is not available the actual cautery may suffice. It is just as important to excise ulcers in scars at an early stage even before they become malignant as to treat early ulcers of the tongue and lip. Several of the ulcerated carcinomata included in this study had been curetted by surgeons at other institutions. The curettage of ulcers in scars is fraught with the danger of hastening dissemination of an unsuspected carcinoma. If the ulcer is small and no deep invasion is apparent, then simple excision is carried out, if invasion of the derma has occurred, then more normal tissue must be sacrificed. The operation must

always be radical with regard to the carcinoma itself. Superficial carcinomata of the hand may be excised without molesting the subjacent bone. We prefer to give radium a trial opportunity for curing these epitheliomata, if the first attempt is unsuccessful, we believe that it is wiser to do a wide extirpation followed by a skin graft. In this case, we find flaps preferable to free skin transplants for the same reasons as given under our discussion of scar excision.

We have statistical evidence to indicate that local excision of scar cancer is unsuccessful and dangerous. The majority of the local excisions were done before the patients came under our observation. There were at least 14 local excisions done on these 28 scar cancers, 13 of these epitheliomata recurred after the operations, only 1 was cured. There are two explanations for these failures, first, the operations were not radical enough, and second, few of these cancers received pre-operative irradiation.

Amputation may be necessary at times to control hemorrhage caused by erosion of a large vessel. Other indications for amputation are (a) when the cancer has invaded so deeply and become so adherent that excision is an impossibility, (b) when the interior of a large articulation such as the knee or ankle is extensively laid open, (c) when large areas of bone are exposed, a condition which results in necrosis, (d) when profound and uncontrollable suppuration of the wound is complicated by fever and a dangerous systemic toxemia of the patient, (e) when the functional result even after a presumptive local cure would be unsatisfactory, the limb becoming an encumbrance to the possessor. Amputations were performed, for one of the reasons which have been stated, on Cases 8, 11, 12, 14, 15, 18, 20, and 24.

There were 11 patients with latent scar cancer situated on their extremities, of these, 7 eventually had amputations, and 1 of the remaining 4 patients has a recurrent epithelioma of the popliteal space which may necessitate an amputation through the thigh. If the carcinoma is on the ulnar side of the hand, the surgeon may conserve the forefinger and thumb of this hand.

Concerning axillary dissection in cases of carcinoma of the hand Mason states "Routine axillary dissection is by no means necessary due to the slow growth of the carcinoma, but it is necessary with a process of two or more years duration." Our management is somewhat different. If there are palpable hard lymph nodes in the axilla or groin, the region is treated first by external irradiation. The roentgen-ray is used or 4 gram radium element pack, filter of 15 millimeters brass and 0.35 millimeters platinum, a distance of 6 centimeters, and a dosage of 16,000 milligram hours. After the skin reaction has subsided, a complete dissection of the axilla or groin is performed, which is sometimes followed by the implantation of gold filtered radon seeds in the depths of the operative field. The cubital, epitrochlear, or popliteal lymph nodes are seldom involved unless the carcinoma infiltrates deeply enough to drain by way of the deep lymphatics into these lymph nodes.

#### TREATMENT BY CAUSTICS

Chemical caustics for the treatment of cancer have been employed for centuries. The Egyptians, Indians, and Persians utilized a paste of arsenic and vinegar which was in use until the middle of the fourteenth century. Modifications of the formula were made from time to time. Velpeau in the early part of the nineteenth century treated cancer with a paste (caustique noir) consisting of sulphuric acid. Maisonneuve made use of a paste, the active agent being zinc chloride.

Zinc chloride was not particularly successful at first for it failed to remove the skin over the tumor. For this reason alkaline caustics and mineral acids found more favor in cancer therapy. "Vienna paste" contained potassium hydroxide and quicklime. In this country Willard Parker was enthusiastically treating cancer of the breast and face with caustics.

The first recorded case of cancer originating in a burn scar treated with zinc chloride paste was reported in 1841 by Cesar Hawkins. Billroth used chemicals in selected cases of cancer but this method fell into disrepute because it had been taken up by charlatans. For

the most part the method is applicable to cancer of the breast and skin, or superficial tumors, such as melanoma and neurogenic sarcoma. Fungating infected and inoperable lesions which precluded orthodox surgical measures were considered suitable.

In cases in which the epithelium is intact it is destroyed by the application of potassium hydroxide. The stick is applied with gentle pressure until the subcutaneous fat is reached. A paste made of flour, charcoal and a saturated solution of zinc chloride is applied. This is allowed to remain for 48 hours. The devitalized tumor tissue is removed with a razor and the paste reapplied. Successive treatments finally reach a base free of tumor tissue. After allowing a granulating base to appear the resulting defect is skin grafted.

The method is primarily a palliative one. Its advantages are that it can be used in infected fields, often destroying foul, ulcerating lesions. The caustic action seals off lymphatics and blood vessels, thus preventing the dissemination of tumor cells and the absorption of toxins. It causes a marked tissue response evidenced by the rich leucocytic infiltration observed in the sections in these cases which have been studied by Ewing.

Two cases in this series were treated in this fashion. The first case, a lesion on the forearm (Case 13), had been treated with radium which failed to control it. The use of zinc chloride was likewise a failure because of the deep invasion of muscle by tumor growth. Continued application of the caustic would have caused serious hemorrhage resulting from the erosion of the deep arteries. Consequently, an amputation through the shoulder joint was done. This patient is now free of disease for almost 5 years.

The second case (Case 17) was an extensive skin cancer of the popliteal space. This case was treated by Doctor William S. Stone with a brilliant initial result. A recent recurrence has been much more resistant and failed to respond in a satisfactory manner to further chemical therapy. Subsequent interstitial irradiation with radon seems to have controlled the recurrence.

We are not unimpressed with this method of treatment for cancer developing in burn scars,

but the number of cases treated in this way is too small to draw definite conclusions

#### IRRADIATION OF SCAR CANCERS

In the radium treatment of scar cancers the following methods of application were employed

1. *Tray of radium emanation* Focal distance of 3 centimeters Radiating surface of 17.5 square centimeters Circular form—6.2 centimeters in diameter Filter of 1 millimeter brass and 0.5 millimeter silver Therapeutic dose of 3,000 millicurie hours With filter of 2 millimeters brass and 0.5 millimeter silver Therapeutic dose of 3,500 millicurie hours

2. *Square plaque of radium emanation* Focal distance of 1 centimeter Radiating surface of 2 square centimeters Square form—1.8 centimeters square Filter of 1 millimeter brass and 0.5 millimeter silver Therapeutic dose of 800 millicurie hours With filter of 2 millimeters brass and 0.5 millimeter silver Therapeutic dose of 900 millicurie hours

3. *Long plaque of radium emanation* Focal distance of 1 centimeter Radiating surface of 3.34 square centimeters Measurement—2.7 centimeters by 1.7 centimeters Filter of 1 millimeter brass and 0.5 millimeter silver Therapeutic dose of 1,000 millicurie hours With filter of 2 millimeters brass and 0.5 millimeter silver Therapeutic dose of 1,200 millicurie hours

4. *Round plaque of radium emanation* Focal distance of 1 centimeter Radiating surface of 4 square centimeters Round with 2 diameter of 4 centimeters Filter of 1 millimeter brass and 0.5 millimeter silver Therapeutic dose of 1,200 millicurie hours With filter of 2 millimeters brass and 0.5 millimeter silver Therapeutic dose of 1,500 millicurie hours

5. *Gold filtered radon seeds for interstitial irradiation* The filter of these implants was formerly 0.2 millimeter gold, now the filter is 0.3 millimeter gold The amount of radon in each seed is between 1.5 and 3 millicuries If the carcinoma is thick, the dosage is computed on the basis of a sphere with the diameter equal to the greatest diameter of the tumor In such a case a tissue dose of at least 10 skin erythema units should be delivered to the

tumor If the epithelioma is quite flat over the surface of the ulcer, the gold seeds can be placed in triangular arrangement, 1 centimeter between seeds of 1 millicurie each to give a tissue dose of 8 skin erythema units If 2 millicurie seeds are employed and placed 1½ centimeters apart, the tissue dose would be 12 skin erythema units

6. *Surface application of radium for the treatment of superficial cancers* An applicator or mold of dental modelling compound may be made to conform with the dimensions of the cancer In the substance of this mouldage are incorporated small silver tubes containing radon The distance of the radon from the surface of the tissue is 0.5 centimeter The filter of silver is 0.5 millimeter The dose varies from 70 to 95 millicurie hours per square centimeter of radiated surface

The Regaud technique for the same indication is as follows The focal distance of the radium from the skin depends on the nature and type of the lesion to be treated, also its depth or height The distance is obtained by the intervention of a wax (Columbia paste) or dental modelling compound which is transparent to the gamma rays of radium If the cancer is small and flat the focal distance may be only 0.6 centimeter, but if it is an elevated or a large lesion, the distance is correspondingly greater as from 1 to 1.5 centimeters The amount of filtration is 1 millimeter of platinum The dosage of radium is variable, depending on the size of the lesion For a small epidermoid carcinoma, such as one 2 square centimeters in area, the dose may be as high as 4½ millicuries destroyed per square centimeter of tumor, but for larger cancers such as one measuring 25 square centimeters in area, the dose is often only 2 millicuries destroyed per square centimeter of tumor

The opinion is generally held that radium therapy is contra indicated in the treatment of scar cancers (Roussy, F. M. Johnson, Strauss) Squamous carcinomata of the skin elsewhere are successfully treated by radium The difficulties attendant on radium therapy of scar cancers are due to at least four reasons (1) the squamous cancers originating in scars are highly differentiated, adult, radioresistant

neoplasms, (2) due to insufficient blood supply, the normal process of repair or tissue reaction following irradiation is weak or absent in the scar bed, (3) the constant infection of these ulcers interferes with successful irradiation, (4) radionecrosis occurs quickly and with relatively low dosage in scar cancer. When irradiation is unsuccessfully employed, it makes the base of the ulcer more fibrotic than ever and impairs healing. In such an event the irradiation should be followed by wide excision and skin grafting.

Ewing's remarks concerning radioresistance are appropriately applicable to scar cancers. "Carcinomata are resistant in inverse proportion to the degree of anaplasia and in direct proportion to the amount of desmoplastic reaction which they excite. The nature of the tumor bed has much influence on the response to radiation, both favoring and in other cases retarding the response to treatment. It is well known that infected tumors which are the seat of exudative inflammation do not react well to treatment. The infection loosens the surrounding tissues and permits infiltration by invading tumor cells, which more readily penetrate tissue spaces, vessels, and lymphatics. Radiation also tends to accelerate the inflammatory process."

The end results of treatment as outlined in Table III, show that 4 latent scar cancers and 4 acute wound cancers were cured by irradiation alone. In 2 other instances, radium therapy of latent scar cancers was successful after surgery had failed. Most of these cancers were small and superficial, with one exception (Case 1).

The following 28 cases are fully abstracted. The analysis of these histories has furnished the basis of this study.

#### CASE REPORTS—ONE TO TWENTY-TWO INCLUSIVE—LATENT SCAR CANCERS

CASE 1. J. L., white male, aged 63 years, reported to the Memorial Hospital July 21, 1927. The patient was 33 years old when he was severely burned on the left side of his face, including the ear, cheek, nose, neck, and chin, and at 58 years the facial scar became ulcerated and would not heal. The ulcer at this time was probably carcinomatous. A time interval of 25 years had elapsed from the date of the burning to the onset of this complication. From 1922 to 1924, he

received from 35 to 40 roentgen ray treatments at another institution, the lesion healed and remained healed for 9 months then broke down again with increased ulceration. Finally, 5 years after the appearance of the neoplastic ulcer he entered the Memorial Hospital.

Physical examination disclosed an irregular, ulcerated lesion, 10 by 4 centimeters in size, involving the left cheek from the region of the temple to below the angle of the mouth. There were no palpable cervical lymph nodes.

Treatment. On August 4, 1927, the patient was given two treatments over this ulcer by a tray of radium emanation. One treatment was over the upper part of the lesion, the other over the lower half. The factors in each exposure were, filter, 2 millimeters brass, distance, 3 centimeters, and dosage 3,431 millicurie hours. The patient has remained cured for a period of 2½ years. The area was slightly denuded over the malar prominence, but there was no evidence of neoplastic disease. The total duration of time from the onset of this cancer to the present date is 8 years.

Microscopical examination of a biopsy specimen of the tumor showed a squamous carcinoma, Grade I, radioresistant.

CASE 2. E. N., white male aged 55 years, reported to the Memorial Hospital on July 20, 1926. Twelve years previously, when 43 years old, he was burned by molten metal on the left side of the forehead. The wound never healed and after a short time began to increase in width and acquire a definite elevated margin.

Physical examination showed that beginning above the left eye, and extending upward and backward to the left temple was a superficial ulcer 7 by 3 centimeters in diameter. The edge of this ulcer was raised and everted. There were no palpable adenopathies.

Treatment. In November, 1925, the ulcer was excised by sharp dissection at another hospital. It promptly recurred. On July 27, 1926, a tray of radium emanation was applied to the upper half of the ulcer, the following radiation factors being employed, filter, 2 millimeters brass, distance, 3 centimeters, dosage 2,993 millicurie hours. On July 30, 1926, a similar treatment by a tray of radium emanation was given to the lower half of the ulcer for 3,430 millicurie hours. There was partial regression of the tumor, but not sufficient to justify further attempts at radium therapy. On October 8, 1926, Dr. Hayes E. Martin did a wide cautery excision and exposed the frontal bone. The outer plate was perforated by multiple drill holes which permitted the growth of granulation tissue out of the diploe. In January, 1930, the patient was living with no evidence of recurrent carcinoma. A small area of bone was still exposed.

Microscopical examination of the excised specimen showed a superficial adenoid cystic epithelioma.

CASE 3. A. L., white female, aged 43 years, reported to the Memorial Hospital on November 5,

1917 When the patient was 22 years old her right temple and forehead were burned by flame. The wound healed rapidly without complication leaving a scar which extended from the malar eminence and supra orbital ridge to the pterion. Twelve years after the occurrence of the burn and 10 years before application to the Memorial Hospital the central part of the scar began to scale and form crusts. She always picked off this scab and soon an ulcer appeared which increased in diameter and became slightly elevated. One year later a definite cauliflower mass was present in this scar.

Physical examination showed on the right frontal region a circular area of uncovered temporo-frontal bone measuring 3.5 centimeters in width. Below this defect was a crescentic mass of tumor tissue 5.5 by 2.5 centimeters in surface dimensions and 1.5 centimeters high. There were some small hard palpable lymph nodes in the right pre auricular and parotid areas.

**Treatment** Since July 1917 three cautery excisions of this tumor were attempted at another hospital. The last cauterization exposed the pericranium. On November 6 1917 the cancer was treated by the application of radium emanation with a filter of 0.5 millimeter platinum a focal distance of 1 millimeter and a dosage of 3,820 millicurie hours. By December 1917 the carcinoma had regressed almost completely. One small portion of the edge of the lesion appeared to be neoplastic. This was treated with a dosage of 484 millicurie hours on March 5 1918. On February 15 1928 the exposed bone seemed to be forming a sequestrum. June 6 1928 the patient died of paralysis following separation of the sequestrum. The actual total duration from the onset of the cancer to death was 9½ years.

The microscopical diagnosis was papillary epithelioma.

**CASE 4.** A W. white male aged 48 years, reported to the Memorial Hospital on June 15, 1925. Thirty years previously, when he was 18 years old his right lower eyelid was burned by a hot cinder which burned its way deeply into the substance of the lid where it became imbedded. Twenty one years after the date of this injury and 9 years before application to this hospital a thick ulcerated plaque appeared on the right lower eyelid.

Physical examination showed on the right lower eyelid a deep infiltrating lesion involving the entire inner two thirds of the lid and extending downward on to the cheek. There were no palpable cervical lymph nodes. The clinical diagnosis was basal cell epithelioma.

**Treatment** On June 19 1925 radium emanation was applied on an applicator of dental modelling compound the factors were, filter 0.5 millimeter silver, distance 0.5 centimeter, dosage, 360 millicurie hours. The lesion disappeared completely. When last seen on July 13, 1928 there was no evidence of disease.

**CASE 5.** A white male, aged 39 years, reported to the Memorial Hospital on February 10, 1927 com-

plaining of an ulcerated scar on his scalp. When the patient was 7 months old his scalp was scalded. Healing occurred by second intention, a firm, white hairless scar being left. Thirty seven years later (1926), small crusts appeared in the center of the scar, later an ulcer developed in this region.

Physical examination showed that the scar involved the scalp from the region of the anterior fontanelle to theinion posteriorly. It was ovoid, white firm and fixed to underlying tissues. The alopecia corresponded to the extent of the scar. Somewhat to the right of the midline of the vertex was an irregular, deep infiltrating ulcer which had hard edges and was immovably fixed. It measured about 4 by 5 centimeters involving both tables at the vault of the skull. There were no palpable cervical lymph nodes. The blood Wassermann test was negative.

**Treatment** In March, 1926, the ulcer had been treated insufficiently by superficial X irradiation. Later the patient was treated by Dr. Douglas Quick who used roentgen rays to produce a marked reduction in the size of this lesion. On February 17, 1927, a tray of radium emanation, filtered by 2 millimeters of brass at a focal distance of 3 centimeters was applied for a dosage of 4,000 millicurie hours. In June, 1927, he had a transient attack of paralysis of his left leg and July 7 1927 developed hemiplegia of his left arm and left leg. Dr. George H. Hyslop attributed this complication to an involvement of the right temporal area by the invasion of meninges and possibly brain by direct extension of the tumor. By July 27, there was a herniation of the brain and envelopes, when dressing the wound, muscular spasms would occur in the scrotal and pelvic girdle muscles. There was a hypertonic paresis of the left arm and left leg. Spasticity of muscles increased and suggested deep damage, some distance below the cortex. The patient died in September, 1927 1½ years after the onset of the cancer.

Biopsy showed squamous carcinoma, Grade II, radioresistant.

**CASE 6.** O. M. a white male aged 84 years, reported to the Memorial Hospital on April 17 1929.

During the Civil War the patient received a gun shot wound of the right elbow which caused some permanent incapacitation. Between the ages of 25 and 35 he was employed in a foundry and during this time he frequently received facial burns from splashes of hot molten metal. In 1879 when he was 33 years old the inner canthus of the left eye and the right side of the nose were rather severely burned by hot molten metal. These burns healed in a few weeks without the intervention of skin grafting. The resultant scar caused a pseudo epicanthus of the left eyelids and a stenosis of the left puncta lacrymalis. In 1923 44 years after the date of the injury an ulcer appeared on the scar of the left inner canthus, this ulcer was treated elsewhere by radium therapy and healed until December 1928 when it reappeared and was again treated by the same method with apparent success. In September, 1928, another ulcer formed

on the scar on the right side of the nose. This lesion grew rapidly. Radium therapy was given at another hospital without success. This is very likely an instance of multiple epitheliomata arising on the base of a scar.

Physical examination showed in addition to the epicanthus of the left eyelids, an ulcer, 3 centimeters in diameter, involving the right side of the nose as far as the nasal tip. The ulcer had raised indurated edges and extended deeply to involve the cartilage of the nose. There were no palpable cervical lymph nodes.

**Treatment** On April 24, 1929, Dr. Douglas Quick elected to do a cautery removal of the nasal growth. The wound healed without difficulty and the patient is now apparently free of neoplastic disease.

Microscopical examination of the excised specimen showed a squamous carcinoma, Grade II, radioresistant. There was some necrosis in the center of the strands.

**CASE 7** E. K., white male, aged 53 years, reported to the Memorial Hospital on October 13, 1927, complaining of an ulcer posterior to his left ear. When the patient was 6 years old, he fell in a bonfire and burned the left side of his neck, the edge of the left ear, his left shoulder, and left arm. Healing was slow, because the area was extensive and no skin grafting was done. A time interval of 44 years elapsed between the date of the burn and the onset of the present tumor growth. When he was 50 years old an ulcer developed in the scar posterior to the left ear, increasing rapidly in size. In 6 months it was 7 centimeters wide and involved adjoining portions of the scalp and neck. A cautery excision of this ulcer was done at another hospital in May, 1925. The tumor recurred and was treated at least 25 times by electro-cauterization, but the recurrent tumor persisted. One roentgen ray treatment was given but resulted in but slight effect on the progress of the growth.

Finally, three years after the date of onset of the tumor, the patient applied to the clinic of the Memorial Hospital. At this time a fixed ulcer, measuring 6 by 10 centimeters, was found on the left side of the neck posterior to the ear. The edges of this ulcer were thick and the tumor tissue was 2 centimeters deep. The base of the ulcer was adherent to underlying bone, which was probably involved by the infiltrative growth.

**Treatment** For treatment, radium therapy was first elected. A tray of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 3 centimeters, and a dosage of 3,900 millicurie hours was applied on October 20, 1927. Another treatment by a tray of radon with the same physical factors was given for 3,500 millicurie hours on November 10, 1927. On November 22, the lesion had regressed markedly. A round plaque of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 1 centimeter, and a dosage of 1,500 millicurie hours was applied over the edge of the carcinoma on December 16, 1927. A similar treatment was given

on December 20, 1927. The carcinoma never regressed completely, necessitating, on March 2, 1928, a cautery excision to include the entire neoplastic and irradiated area. The patient later developed left cervical lymphadenopathies which were probably due to metastases. He died on February 21, 1929, 4½ years after the date of onset of the cancer.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant.

**CASE 8** M. R., white male, aged 62 years, reported to the Memorial Hospital on November 19, 1920. When the patient was 42 years old he was burned on the left side of his neck by some hot cinders. The wound healed slowly. Later an ulcer appeared in the scar of this burn. The patient was unable to state the exact date of recognition of this ulcer. It slowly increased in size and depth.

Physical examination showed on the right side of the neck a large, deep ulcer measuring 4 by 4 centimeters. The edges were hard and raised. There were no palpable cervical lymph nodes. The clinical diagnosis was basal cell epithelioma.

**Treatment** In July, 1920, the ulcer was excised at another hospital, but it rapidly recurred. On November 19, 1920, radium emanation was applied on an applicator of dental modelling compound, the factors were, filter, 0.5 millimeter silver, distance, 0.5 centimeter, dosage, 250 millicurie hours. On November 26, 1920, a similar treatment was given for a dosage of 276 millicurie hours. On June 3, 1924, Dr. Bradley Coley did a cautery excision of the persistent ulcer, but the neoplasm again recurred. On August 22, 1925, another excision was attempted by Dr. Hayes E. Martin, but the tumor again recurred. On February 12, 1926, 2 gold radon seeds containing a total amount of 3.34 millicuries were implanted in a nodule which was in the scar. On June 1, 1928, another gold radon seed containing 2.99 millicuries was implanted in a small nodule in the scar. When last seen on February 21, 1930, there was no evidence of disease.

Microscopical examination of the excised specimen showed a basal cell epithelioma, markedly affected by irradiation.

**CASE 9** T. K., white male, aged 38 years, reported to the Memorial Hospital on January 31, 1930. The patient is by occupation a locomotive engineer. In 1914, when he was 22 years old, an oil immersed switch in his electric locomotive exploded and threw flaming oil over his head and neck. His ears were burned off and there was a deep burn involving the back of the neck and the sides of his head. The wound was not skin grafted and did not heal completely for 2 years. In the latter part of October, 1929, he became aware of a small ulceration in the middle of the scar on the back of his neck. This lesion gradually increased in size during the 3 months preceding his admission to the Memorial Hospital. A time interval of 15 years and 9 months elapsed between the occurrence of the burn and the onset of ulceration. He had had no treatment for this condition.

Physical examination disclosed on the back of the neck a moderately thick slightly puckered scar which swept around both sides of the neck to involve the stumps of both ears. At a point 1 centimeter to the left of the midline of the back of the neck was a circular, raised ulcerated, crusted lesion with rolled up edges. The center was occupied by soft yellowish gray granules of necrotic material. The ulcer measured 2.5 centimeters in both diameters and was 4 millimeters thick. A chain of small, firm, movable pea sized lymph nodes was felt in the left posterior cervical triangle but was considered inflammatory in nature.

*Treatment.* On February 7, 1930 the ulcer was treated by the application of a round plaque of radium emanation; the following factors were used: filter 3 millimeters brass; distance 1 centimeter; dosage 1,600 millicurie hours. On March 7, 1930 there was marked regression of the ulcer. A note by Dr. James Duffy stated that probably all the cancer was destroyed.

Microscopic examination of a biopsy specimen showed a squamous carcinoma Grade II, radioresistant.

**CASE 10.** M. B. white female aged 67 years, applied to the Memorial Hospital on December 9, 1926. When the patient was 3 years old she burned the dorsum of her left hand. One year prior to admission to the Memorial Hospital the scar became swollen and red. 3 months later an ulcer appeared with elevated edges and firm base. An interval of 63 years elapsed between the occurrence of the burn and the onset of this ulcerated lesion.

On the dorsum of the left hand and dorsum of the third and fourth fingers to the first interphalangeal joint there was a necrotic ulcer  $5\frac{1}{2}$  centimeters in diameter. This ulcer extended into the web, probably involving the tendons. One hard lymph node was palpated in the apex of the left axilla. A radio-graph of the chest on March 4, 1929 was negative.

*Treatment.* Before admission the patient had received 6 radium and 12 roentgen ray treatments elsewhere without appreciable effect on the size of the ulcer. She had also received colloidal gold treatments: 27 intravenous injections of 150 drops each. On December 11, 1926 2 low voltage roentgen ray treatments were given to the left axilla. On December 23, 1926 a tray of radium emanation with a filter of 2 millimeters brass and a distance of 3 centimeters was applied for a dosage of 4,000 millicurie hours. There was an immediate response to the use of the radon tray but the tumor did not regress entirely. The complications of sloughing and infection required an amputation through the distal part of the forearm which was done on February 16, 1927. On October 1, 1928 the left axilla was dissected and the carcinomatous lymph nodes removed. At the same time 28 millicuries of radon in 14 gold seeds were buried in the axillary wound. A large recurrent tumor appeared in the left axilla which was treated by interstitial irradiation on March 4, 1929 47 millicuries of radon in 24 gold seeds being used.

In spite of treatment the metastatic cancer in the left axilla continued to grow and infiltrate the surrounding tissues. The patient died in January 1930, almost 4 years after the date of onset of the tumor.

The original biopsy was reported as a papillary squamous carcinoma. The amputated specimen and the axillary nodes contained squamous carcinoma, Grade II, radioresistant.

**CASE 11.** W. M., white male aged 79 years, reported to the Memorial Hospital on May 25, 1927. When he was 20 years of age his face and the backs of both hands were severely burned by a gunpowder explosion. No skin grafting was done and the wounds healed in 3 months. Forty four years elapsed without trouble referable to these areas until 1912 when an intractable ulcer developed in the scar on the dorsum of the right hand. After 2 years of unsuccessful local treatment the right hand was amputated. There were no palpable axillary lymph nodes. There has never been any evidence of recurrence of this epithelioma to date, a free interval of 16 years.

*Present illness and treatment.* In February, 1929 a small keratotic wart was noticed in the scar on the dorsum of the left hand. Although no confirmatory biopsy was taken this lesion was considered an early squamous carcinoma. This small lesion was treated successfully by the application of radon in a glass filtered bulb. The patient also has a small epithelioma on his facial scar at the present time.

**CASE 12.** D. W. white male aged 75 years reported to the Memorial Hospital on January 20, 1927. He complained of an ulcer on the back of his right hand. Six years previously when he was 69 years old he burned the dorsum of his right hand by hot tar. The burned skin never healed completely and 1 year later, a wart appeared on this area which was treated successfully by cautery. After a free interval of 42½ years and 4 months prior to admission to the clinic the wartlike lesion recurred and grew very rapidly with central ulceration. He experienced no pain.

Examination showed the ulcer to measure 2½ by 4 centimeters and to extend to the base of the index finger and over the second metacarpal bone. There were no palpable axillary lymph nodes. On February 1, 1927, a radiograph of the right hand was negative for bone involvement. On March 30, 1927 a radiograph of the chest showed evidence of chronic pulmonary tuberculosis.

*Treatment.* Pre operative irradiation of the cancer was given on January 31, 1927, by the radium emanation pack at 6 centimeters distance with a filter of 2 millimeters brass and a dosage of 20,000 millicurie hours. The same treatment was given to the right axilla as a prophylactic measure. On February 7, 1927, the involved index finger, the corresponding metacarpal bone, and the superjacent ulcerated cancer were surgically removed under local anesthesia. On March 30, 1927 a high voltage roentgen ray treatment was given to the right axilla as an additional prophylactic procedure. At the

present time there is no evidence of cancer. Over 3½ years have elapsed since the onset of the cancer and 3 years since the successful surgical intervention.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant.

CASE 13. O. G., white male, aged 54 years, applied for treatment at the Memorial Hospital on February 6, 1924. When the patient was 9 years old, he burned the lower half of the left arm, the corresponding elbow, and the upper half of the left forearm by flame. A time interval of 44 years and 7 months elapsed between the date of the burn and the onset of the present tumor growth. Five months had elapsed between the appearance of the tumor and admission to the clinic.

On the anterior and outer aspect of the left elbow was an ulcer with indurated edges, which measured 4 by 6 centimeters. On the outer margin of this ulcer was a cauliflower tumor 4 centimeters wide and 2½ centimeters high. The lesion was surrounded by a thin hairless scar. The left axillary lymph nodes were enlarged but soft. A radiograph of the arm demonstrated that the bones were not involved by the tumor.

**Treatment.** For treatment, radium therapy was first elected. A tray of radium emanation, with a filter of 2 millimeters of brass, a focal distance of 3 centimeters, and a dosage of 3,000 millicurie hours was applied 5 times in 1924, on February 14, February 26, June 3, June 10, and August 27, for a total dosage of 15,000 millicurie hours. There was marked temporary regression of the tumor, but recurrence soon followed. On November 26, 1925, the lesion was electrocoagulated. On March 19, 1925, the recurrent tumor mass was treated by the application of a caustic paste made of flour, charcoal, and a saturated solution of zinc chloride. This treatment was also ineffectual. Two low voltage roentgen ray treatments were given to the left axilla, one on July 26, 1925, the other on October 26, 1926. Because all local efforts seemed to be futile, on December 11, 1925, the left arm was disarticulated at the shoulder joint and the left axilla was dissected. At the time of this operation, 164 millicuries of radon in gold filtered seeds were buried in the axilla. Convalescence was uneventful. At present, there is no evidence of disease. Six years have elapsed since the onset of the cancer and 4 years since the disarticulation of the humerus at the shoulder joint.

Histologically, the tumor was a papillary squamous carcinoma, Grade II, radioresistant. The nodes were not involved.

CASE 14. J. T., white male, aged 61 years, reported to the Memorial Hospital on November 14, 1928.

In 1900, when he was 33 years old, both hands, both forearms, and the back of the neck were burned by an explosion of hot tar pitch. The burned area was treated by applications of aristol and powdered starch. No skin grafting was done and the lesion did not heal completely for one year after the occurrence of the accident. Twenty-four years later (1924), the

scarred forearm was reburned by contact with a hot radiator. A blister formed, followed by an ulcer which progressively increased in size. Treatment of this ulcer by his local physician consisted of infra red light, mercurochrome, copper sulphate, diathermy, and electro desiccation. On October 2, 1928, the ulcer was widely excised by another surgeon, who implanted gold filtered radon seeds into the bed of the operative field. The cancer recurred rapidly and the patient presented himself immediately at the Memorial Hospital, 4 years after the onset of the cancer.

On the left forearm was a smooth, hairless, dry scar, a similar scar was on the back of his neck. There was some contraction of the flexor tendons of the left forearm. On the right forearm was an ulcerated, foul smelling, necrotic ulcer, serpiginous in outline and measuring 6 by 10 centimeters. The edges were rolled, hard, and elevated, there was a granulation tissue base of the ulcer. The patient suffered severe pain and almost complete loss of function of the arm. There were no palpable axillary lymphadenopathies. The diagnosis was epidermoid carcinoma.

**Treatment.** Amputation was advised and refused. However, in January, 1929, the arm was amputated at another hospital and at the present time (one year later) there is no evidence of neoplastic disease.

CASE 15. T. T., white male, Italian, aged 56 years, applied to the Memorial Hospital on June 22, 1918. When the patient was 3 years old, he severely scalded his left foot. No skin grafting was done and the wound healed very slowly. A time interval of 52 years elapsed between the date of the burn and the onset of the present tumor growth. One year had elapsed between the appearance of the tumor and admission to the clinic.

On the dorsum of the left foot was an ulcer with everted edges and a diameter of 3 inches. In the right groin were some palpable lymph nodes which were not considered neoplastic. A radiograph on July 6, 1918, showed no evidence of bone destruction, the bones of the foot were osteoporotic due to atrophy of disuse.

**Treatment.** In January, 1918, the ulcer of the foot and two of the subjacent bones were excised at another hospital. The recurrent ulcer was first treated at the Memorial Hospital by the application of radon to a moulage of dental modeling compound. This treatment was given on July 6, 1918, and consisted of the following factors, distance, 0.5 centimeter, filter, 0.5 millimeter silver, dosage, 3,230 millicurie hours. The disease was not controlled so on August 13, 1918, glass seeds containing 11.5 millicuries of radium emanation were implanted in the lesion. The cancer was very radioresistant and was inseparably fixed to the underlying bone. On November 1, 1918, the left foot was amputated. The stump healed quickly and the patient was without evidence of the disease 6 months later. Since that time he has been lost to further observation.

The microscopical diagnosis was epidermoid carcinoma, Grade II, radioresistant.



**CASE 16** E. D., white male aged 19 years, was referred to the Memorial Hospital on May 11, 1928. When the patient was 3½ years old his entire right leg from hip to ankle was scalded. Healing was delayed because of the great surface denuded and the failure to employ skin grafting. The resultant scar involved the skin of the right thigh and leg and caused a marked contracture of the knee joint. In 1922 the scar over the knee became fissured and ulcerated. These ulcers would heal and later recur. Finally 14 years after the occurrence of the burn a persistent ulcer with indurated edges appeared. Enlarged hard palpable lymph nodes were found later in the right inguinal region.

*Treatment and course.* In November, 1927 a dissection of the right inguinal region was done at another hospital followed in 1 week by an amputation of the right thigh. In May 1928 a subcutaneous lump was detected in the region of the left scapula. On May 5, 1928 this lump was excised and found to contain metastatic epidermoid carcinoma. At the time of admission to Memorial Hospital 18 months after the appearance of the tumor he had hemoptysis of 3 weeks duration. There was no evidence of local recurrence at this time but the right base of the chest was dull to percussion and a radiograph of the chest on May 11, 1928 was positive for pulmonary metastases. The patient died in October, 1928 2 years after the onset of the cancer. The microscopical diagnosis was squamous carcinoma.

**CASE 17** E. S., white male aged 67 years reported to the Memorial Hospital on February 25, 1909 with the complaint of a tumor growth on the back of his left knee. When the patient was 18 years old a discharge from a Roman candle burned him in the left popliteal space and a large part of the surface of the left thigh. After the burn he was unable to walk for 9 months. No skin grafting was done and the denuded area did not heal completely for 3 years. Every 3 or 4 years the scar in the popliteal space would break down, become fissured or ulcerate, and then heal. In 1899 such an area in the scar became severely infected and when healing occurred the left leg became so lymphoedematous that he was compelled to wear an elastic stocking. Finally 46 years after the date of the accident and 3 years prior to admission to the Memorial Hospital, the popliteal scar became ulcerated and would not heal. A fungous growth originated on the edge of this chronic ulcer.

On examination a dense scar was observed to extend from the left groin down the medial aspect of the thigh to involve the left popliteal space. At the lower end of this scar was a fungating, ulcerating tumor, measuring 5 by 8 centimeters. There were no palpable inguinal lymph nodes. Radiographs of the lungs and left knee on February 25, 1929 showed no evidence of pulmonary metastasis but a chronic atrophic osteo arthritis of the knee.

*Treatment.* On February 11, 1929 the lesion was given one roentgen ray treatment at another

hospital, the factors were spark gap, 9 inches milliamperage, 5, target skin distance, 15 inches, filter, 5 millimeters aluminum, time 7 minutes. This treatment had no appreciable effect on the size or growth of the tumor which was a radioresistant type of neoplasm. Dr. William S. Stone treated this cancer by the application of a caustic paste consisting of a saturated solution of zinc chloride incorporated in flour and powdered charcoal. All local evidence of the carcinoma disappeared and the wound healed completely. After a free interval of 1 year, a recurrent nodule was recently noticed in February, 1930. This has subsequently disappeared following the treatment by means of radon implants.

The microscopical diagnosis was squamous carcinoma, Grade I, radioresistant.

**CASE 18** D. J., a white male aged 54 years was seen by Drs. William B. and Bradley I. Coley and was admitted to the Fifth Avenue Hospital on October 28, 1927. He complained of the presence of an ulcer in the skin on the posterior aspect of the left lower leg. This patient while at work, sustained a severe burn over the calf of the left leg when his overalls were set on fire. This accident occurred 22 years prior to his admission. Healing was quite slow, requiring 7 years for complete epithelization. Two years later ulceration appeared in the center of the scar. For 13 years there has been slow extension of the lesion.

Physical examination showed that the entire skin surface on the posterior aspect of the left calf, extending from the popliteal fossa to within 3 inches of the ankle joint was replaced by a foul smelling ulcerating lesion. The base consisted of a papillomatous red friable material which bled easily. The edges of the involved area were irregular, raised and of firm consistence. The area which had been burned was completely transformed into this ulcer. Several enlarged lymph nodes were palpated in the left inguinal space, but clinically they did not appear to be metastatic.

*Treatment.* After a period of 12 days rest in the hospital the ulcerating area had been freed of gross infection by the use of Dakin's solution and mercuriochrome. On November 10, 1927, a mid thigh amputation of the left leg and inguinal dissection was done by Dr. Bradley I. Coley. Postoperative convalescence was uneventful and the patient left the hospital December 20, 1927. The patient has remained free of disease.

The microscopical diagnosis was squamous carcinoma, Grade II, radioresistant. The lymph nodes were free from metastases.

**CASE 19** A. V., white female, aged 47 years reported to the Memorial Hospital on January 1, 1909. When the patient was 38 years old she dropped two hot boiled eggs and boiling water on the inner aspect of the right thigh in the region of the femoral trigone. The scald was of moderate severity and healed by epidermatization in 3 months. No skin grafting was done. The scar was thick and hyperkeratotic, the patient continually picked at the

epithelial flakes which formed on the surface of the scar. Finally, 7 years after the date of scalding, an ulcer appeared in the center of this scar. This ulcer had been present for 2 years before the patient applied to the Memorial Hospital.

Physical examination disclosed a large ulcerated, sloughing lesion involving the right thigh from 2 inches above the knee to 1 inch above the inguinal ligament, including the entire medial aspect of the thigh and extending posteriorly and upward to within  $1\frac{1}{2}$  inches of the anal orifice, taking in almost the entire buttock on the right side. The ulcer was severely infected and its base was formed of hard, scarred tissue. A sinus  $3\frac{1}{4}$  inches long extended upward below the skin of the abdomen. There was marked bilateral contracture of the thighs which were constantly flexed at an angle of 45 degrees with the abdomen. Although this cancerous ulcer was enormous and was suppurating profusely, there were no palpable adenopathies.

**Treatment.** On February 4, 1929, a treatment of unfiltered low voltage roentgen rays was given to the involved area, the factors employed were: target skin distance, 15 inches; current, 4 milliamperes; spark gap, 10 inches; time, 10 minutes. There was no demonstrable beneficial effect on the size of the cancer. The location and extent of the disease contraindicated any surgical interference. The patient died on April 27, 1929, 27 months after the date of onset of the cancer.

Microscopical examination of a biopsy specimen of the tumor revealed a squamous carcinoma, Grade I, radioresistant.

**CASE 20.** M. H., white female, aged 46 years, applied to the Memorial Hospital on October 5, 1918, when the patient was 9 years old, she sustained a severe third degree burn of both buttocks, thighs, and legs. No skin grafting was done and the wound healed very slowly with the formation of dense adherent scars and some contractural deformity. In 1903, the scar on the left leg broke down, became ulcerated, and caused severe pain. This ulcer was excised and the wound skin grafted in 1908.

In 1910 the right leg was amputated because of an intractable ulcer which developed on the scar. In 1911, a sore on the right buttock was curetted. In 1912, a sinus developed on the left thigh and buttock and began to discharge necrotic fragments of bone. In 1915, an exploratory incision was made into the depths of this sinus. In July, 1917, the stoma of the sinus began to increase rapidly in size and to assume the characteristics of a malignant ulcer of the Marjolin type. The time interval elapsing between the occurrence of the burn and the onset of the cancer was 37 years. Fifteen months elapsed between the onset of the cancer and admission to the Memorial Hospital.

Physical examination on admission disclosed a large fungating ulcer of the left thigh and buttock. The ulcer measured 10 centimeters by 12 centimeters. There was found no evidence of regional or distant metastases.

**Treatment.** In February, 1918, several roentgen-ray treatments were given to the ulcer of the left thigh and buttock, but without demonstrable benefit. The previous operations consisting of excision and grafting, amputation of the right leg, curettage of the ulcer, and finally exploratory incision exhausted the possibilities of further surgery, and no treatment of any kind was given at the Memorial Hospital. The patient died on January 17, 1919, 19 months after the date of onset of the tumor.

**CASE 21.** D. B., white male, aged 50 years, reported to the Memorial Hospital on November 12, 1926. When the patient was 38 years old, his back was burned by flaming alcohol due to an accident in cupping. This burn never healed and the superficial ulcer gradually became obliterated by a slowly growing nodule. During the 12 year interval before admission to the clinic, this tumor had grown to a size of only 134 centimeters in diameter.

Physical examination showed on the skin of the back at the level of the iliac crests and slightly to the left of the midline an ulcerated nodular plaque, measuring  $1\frac{1}{4}$  by  $1\frac{3}{4}$  centimeters. The surface of the lesion was elevated above the surrounding skin. The nodule and the adjacent skin were freely movable over the subcutaneous tissues, which indicated the superficial character of the neoplasm.

**Treatment.** The treatment elected was a surface application of radium. After a biopsy on November 24, 1926, a plaque of radium emanation was applied with a filter of 2 millimeters of brass, a focal distance of 1 centimeter, and a dosage of 1,000 millicurie hours. On February 9, 1927, another radium treatment was given with a plaque for a dosage of 1,200 millicurie hours. The tumor responded readily to irradiation and soon disappeared. Three years have elapsed since this treatment and at the present time there is no evidence of disease.

The microscopical diagnosis by Dr. James Ewing was squamous carcinoma. There were some areas in the biopsy section which resembled adenoid cystic epithelioma.

**CASE 22.** E. C., a negroess, aged 75 years, was first seen at Memorial Hospital on June 25, 1921, complaining of a tender inflamed area in the left scapular region. When she was 6 years old, her left upper arm, left shoulder, left scapular and left posterior thoracic regions were scalded severely. A time interval of 69 years elapsed between the date of the burn and the onset of the present tumor growth. Two months had elapsed between the appearance of the tumor and admission to the clinic. The clinical diagnosis was squamous carcinoma. In April, 1921, small shotty nodules appeared in the center of the scar in the scapular region. These nodules coalesced, increased in size, and finally ulcerated. Definite hard lymph nodes were palpated in the left axilla.

**Treatment.** On July 7, 1921, a radium treatment was given to the scapular lesion. Silver filtered tubes of radon (0.5 millimeters silver) were applied on a mould of dental modelling compound over an area of 4 centimeters, at a distance of 0.5 centimeters,

for 280 millicurie hours. There was some regression in the size of the epithelioma, but a cure was not effected. The patient died on May 12, 1922, 13 months after the assumed date of onset of the cancer.

# CASE REPORTS—TWENTY THREE TO TWENTY-EIGHT INCLUSIVE

## ACUTE WOUND CANCERS

**CASE 23** F C, white male, aged 65 years reported to the Memorial Hospital on February 27, 1924. One year previously he burned the extensor surface of his right arm and the dorsum of his right hand by spilling hot molten wax on these members. The burned region never healed, one small central area remained persistently ulcerated. No skin grafting was done.

Physical examination on admission revealed an irregular ulcerated tumor on the skin of the dorsum of the right hand. This tumor was 2.5 centimeters broad and 1 centimeter thick. With the adjoining skin it was freely movable over the subcutaneous tissues. There were no palpable axillary lymphadenopathies. The patient had the characteristic symptoms of advanced pulmonary tuberculosis, namely, cough, hemoptysis, asthenia, loss of weight, and night sweats. A radiograph of the chest on March 8, 1924, showed extensive pulmonary tuberculosis in both apices, more marked on the right side.

**Treatment.** A tray of radium emanation with a filter of 2 millimeters of brass, a focal distance of 3 centimeters and a dosage of 3,000 millicurie hours was applied over the lesion on March 4, 1924. When seen on March 20, a good local response was noted but the patient died on April 1, 1924. The actual total duration of time from the onset of the cancer until death was 1 year, however, death was attributed to the pulmonary tuberculosis rather than to the localized epithelioma.

The microscopical diagnosis of a biopsy specimen was squamous carcinoma, Grade I+, radioresistant.

**CASE 24** W F, white male, aged 70 years came to the Memorial Hospital on July 20, 1922. The dorsum of this patient's left hand had been the seat of chronic eczema following ivy poisoning. Keratotic warts had been cauterized by acids several times before the hand was burned. In March 1922, 4 months before he reported to the Memorial Hospital, this same area was burned by burning timber. This thermal trauma seemed to be the final inciting factor in the development of epithelioma on this location. The burned area never healed and the superimposed cancer developed gradually and insensibly on this wound.

Physical examination revealed on the dorsum of the left hand over the first metacarpal bone a deep fixed ulcer with heaped up edges, 1.5 centimeters in width. There were no palpable axillary lymph nodes. A radiograph of the hand on July 21, 1922, showed no evidence of bone destruction.

**Treatment.** On July 20, 1922, the epithelioma was treated by radium emanation, which was applied on a mouldage of dental modelling composed for a dosage of 771 millicurie hours with a filter of 0.5 millimeters silver, and a focal distance of 0.5 centimeter. The cancer was destroyed completely by this treatment, but the resultant slough of the necrotic tumor tissue left the metacarpal bones exposed. This condition necessitated an amputation, which was done through the forearm on October 25, 1922. At the present time 8 years after the onset of the cancer the patient, now 78 years old, has no evidence of his original cancer but is under treatment for a small epidermoid carcinoma of the lower lip.

**CASE 25** J K, white male, aged 35 years was first seen at Memorial Hospital on April 23, 1928. Seven years previously, when he was 28 years old, he was burned by some flaming sparks on his right cheek. The wound never healed and soon developed a small nodulation in its center. In 1922, this nodule was cauterized by carbon dioxide snow without appreciable effect. In 1923, it was surgically excised, but soon recurred.

Physical examination revealed a superficial ulcer with raised edges situated on a superficial scar of the skin of the right cheek. There were no palpable adenopathies. The clinical diagnosis was basal cell epithelioma.

**Treatment.** On May 2, 1928, a plaque of radium emanation was applied to the ulcer. The following factors were employed: filter 2 millimeters brass, distance 1 centimeter, dosage, 900 millicurie hours. The reaction was a full therapeutic erythema. The tumor disappeared completely and when the patient was seen last on March 13, 1930, there was no evidence of disease.

**CASE 26** C C, white female, aged 55 years sought treatment at the Memorial Hospital on December 13, 1926. Eighteen months previously, she was burned by hot liquid fat on her left cheek below the eye. The wound never healed and in a very short time an elevated ulcerated nodule appeared.

Physical examination revealed on the left cheek below the eye, situated on a superficial scar, a small tumor 1.5 by 1.5 centimeters wide and long and 4 millimeters thick. The edges of the ulcerated tumor were elevated and rolled. The clinical diagnosis was basal cell epithelioma.

**Treatment.** On December 22, 1926, a plaque of radium emanation was applied to the neoplasm. The following factors were employed: filter 2 millimeters brass, distance 1 centimeter, dosage 1,000 millicurie hours. A cure evidently resulted. On September 20, 1929, when last seen, there was no evidence of neoplastic disease.

**CASE 27** J McD, white male, aged 66 years was first seen at the Memorial Hospital on December 15, 1926. One year previously, his left temple was burned by contact with a hot stove. The burn was of a limited area and was superficial in its involvement. The wound healed slowly and 3 months later a nodular tumor appeared in the scar.

Physical examination revealed on the left temple an ulcerated, raised, indurated lesion  $\frac{3}{4}$  by  $1\frac{1}{2}$  centimeters in diameter. It was situated on a superficial scar. The clinical diagnosis was basal cell epithelioma.

**Treatment** On December 15, 1926, a square plaque of radium emanation was applied to the lesion on the left temple, the following factors were employed: filter, 2 millimeters brass, distance, 1 centimeter, dosage, 750 millicurie hours. The lesion disappeared completely and quickly. On October 15, 1929, when last seen there was no evidence of disease.

**CASE 28** A D, white male, aged 57 years, reported to the Memorial Hospital on November 14, 1928. The patient was employed in a brass factory. He frequently burned the left side of his face and his left eyelids by hot flying brass chips. In April, 1927, a burn by a hot chip left a scar and a definite deformity in the left lower eyelid. On October 23, 1928, another hot chip burned the eyelid in the same location, this chip was buried in the scar and had to be extracted. Three weeks after this last burn and before the wound had healed a small nodule appeared on the eyelid at the site of the injury.

Physical examination showed in the middle third of the left lower eyelid a white, pearly, non-ulcerated tumor. The clinical diagnosis was basal cell epithelioma.

**Treatment** On November 23, 1928, a long plaque of radium emanation was applied to this lesion. The following factors were employed: filtration, 2 millimeters brass, distance, 1 centimeter, dosage, 1,000 millicurie hours. The lesion disappeared completely. When last seen on November 21, 1929, there was no evidence of disease.

Six additional cases are reported. These have not been included in the statistical study because we feel that Ewing's postulates have not been completely fulfilled or that the clinical or laboratory data were incomplete.

**CASE 29** H K, a white male, aged 63 years, had a deep, excavated, infected ulcer,  $1\frac{1}{2}$  centimeters in diameter, on his right cheek. The edges were firm, indurated, and raised. Histologically, it was a squamous carcinoma, Grade II, radioresistant. Forty years previously, he burned his right cheek by hot cigar ashes. The resultant sensitive scar repeatedly broke down and in attempts to heal, formed crusts. Six weeks prior to admission, a wart like growth developed on the scar and grew rapidly. Eleven years previously the skin below the inner canthus of the left eye was burned by splashing hot tar. At an indefinite later period an ulcer arose in this scar, but increased in size very slowly. At the time of application to the Memorial Hospital on August 20, 1927, this latter lesion was firm, nodular, and elevated. The epithelioma of the cheek was cured by the application of a round plaque of radium emanation for 1,570 millicurie hours, followed by the interstitial implantation of 9.5 millicuries of radon

in gold filtered seeds. The lesion on the eyelid was cured by the application of a square plaque of radium emanation for 700 millicurie hours, followed by the interstitial implantation of 3.7 millicuries of radon in gold filtered seeds.

**CASE 30** D M, a white male, aged 63 years, had a superficial irregular, ulcerated epithelioma, 1 by  $\frac{1}{2}$  centimeter, on the left lower eyelid. Two years previously he had burned this lid in this location by a splash of molten lead. A cure was effected in 1926, by the application of a square plaque of radium emanation for 650 millicurie hours.

**CASE 31** K D, a white female, aged 38 years, had a small ulcerated epithelioma originating in a well marked scar of the right lower eyelid. When the patient was 28 years old, she received a powder burn of her nose and right eyelids, the epithelioma developed 7 years later after an attempt to remove powder grains from the scar by the application of iodine. A cure was effected by the application of unfiltered radium emanation in a bulb.

**CASE 32** M B, an Irish widow, aged 65 years, had a small epithelioma, 5 by 3 millimeters, on the right side of her nose. This lesion developed on a scar of a burn which she received in childhood, from contact with a hot stove. It was cured by a short application of unfiltered radium emanation in a bulb.

**CASE 33** H E, a white widow, aged 53 years, had an infiltrating, ulcerated squamous carcinoma, 2 by  $1\frac{1}{2}$  centimeters, over the right zygoma. One year previously she had burned this area with a curling iron, about 10 months later, an ulcer developed in the scar. A cure was effected in 1925, by the application of a round plaque of radium emanation for 1,602 millicurie hours.

**CASE 34** S A, a white female aged 33 years, burned her left cheek by hot bacon fat. Four years later a superficial, raised, ulcerated epithelioma 8 by 5 millimeters appeared on the scar. It disappeared in 1926, after the application of 70 millicurie hours of radon in a lightly filtered silver tube.

#### SUMMARY

A series of cases of carcinoma developing in the scars of burns is reported. These tumors are divided into two groups: the acute wound cancers and the chronic scar cancers.

The potentiality of a scar to undergo malignant degeneration and the histological variety of epithelioma resulting are due to the extent of the surface area involved and to the depth of the burn. The nature of the exciting agent, its capacity for heat absorption and degree of temperature together with the duration of contact are factors which influence such a change.

The age of the scar is more important than the age of the individual. The chronic scar

cancers, in this study, occur at the average age of 53.5 years, while the acute wound cancers develop at 56 years average age. Cancer of burn scars may occur in younger persons if the cicatrix exists from infancy or childhood.

Acute wound cancers develop within a year of the date of injury, occurring in instances of quite superficial burns with little surface involvement. They are more common in older people with atrophic, keratotic skin.

Basal cell cancers developing in burn scars usually occur when the burn is superficial, sparing the hair follicles and sweat glands. This type is noted following thermal injury by hot solids.

Avascular scar tissue results from the slow healing of a burn. Infection in ungrafted burns retards epithelization. Scars slow to heal are more liable to carcinomatous degeneration. Areas which heal rapidly have pliable soft surfaces.

Burns may be classified according to their end results: those that heal with scar formation and those that are repaired without marked scarring. The surgeon, from clinical experience, will recognize which type of burn is to have special treatment in an attempt to minimize scar tissue. The burn which would result in excess scar formation is of significant import in the study and prevention of scar cancer. The tight, thick, dense scar is the one most liable to carcinomatous degeneration, but acute wound cancers, of basal cell type, often originate on wounds of a superficial character. In the contractures following thermal injury and the tension which results, ulceration is easily provoked which may lead to carcinomatous change. Ulceration occurs because newly formed scar tissue is poorly nourished. The fibrosis about blood vessels in the cicatrix prevents an adequate supply of blood to the scar, favoring ischemic ulceration.

The history of scar carcinoma conforms with the generally accepted theory of the histogenesis of epitheliomata. Fibrosis causes poor nutrition and poor nutrition facilitates ulceration. Trauma easily destroys the delicate epithelium. Healing after each insult is more difficult. The regenerated integument is progressively inferior and persistent stimu-

lation to the marginal epithelium for repeated growth and repair with constant frustration may lead to a loss of tissue restraint and eventually cancer.

The epithelium of adherent scars is abraded by relatively slight injuries, while normal skin is not so readily injured by trauma, because of its elasticity and ability to move over subcutaneous tissues. Likewise the trauma in a cicatrix, due to motion of a joint, may be a source of repeated injuries to the scar, a competent producing factor of cancer in such cases. Persistent pruritus may lead to dangerous complications because the patient scratches the area, rubbing off flakes of keratinized epithelium which leaves small raw spots. These may coalesce to form an ulcer, especially when infected. Prolonged suppuration may be a frequent causative antecedent of cancer in these locations.

Cancer in burn scars occurs in those parts of the head and extremities most subject to burns. Many of the carcinomata personally observed have developed in regions where ordinarily epitheliomata are infrequent—arm, elbow, groin, and popliteal space.

When carcinomatous degeneration begins it is often confined to the margins of the ulcer. There are two forms of this cancer: (1) the flat indurated, infiltrating, ulcerating carcinomata, and (2) the papillary carcinoma. The latter form is infrequent. The former is invasive late in its course. Histologically and clinically, the ulcerative variety is a more malignant cancer. This form metastasizes earlier. All the epidermoid carcinomata in this study were squamous cancers, Grades I and II, well differentiated and radioresistant. Because they are adult, differentiated neoplasms arising in areas of scar tissue, growth is slow and dissemination is late. Once the cancer is beyond the cicatrix it may invade or metastasize more readily. Visceral metastases are rare, only one of our cases developed secondary deposits which occurred in the lungs.

As elsewhere in the body, the early recognition of scar cancer is imperative if a satisfactory result is to be obtained. Late diagnoses may require mutilating operations in an attempt to effect a cure. Scar cancers on the

face and head are more serious than similar neoplasms arising on the extremities. Radical surgery in the former group is precluded, while an amputation of a limb may effect a cure as a last resort in the latter group. The presence of invaded lymph nodes is of serious prognostic import, much more so than the duration of the disease. The prognosis is modified by the location of the tumor, its fixity, its proximity to blood vessels, the degree of infection, and the radiosensitivity. The age of the patient may influence the end-result, for old people will not readily tolerate radical surgical procedures while the disease in younger individuals has greater growth propensities. The ultimate prognosis for acute wound cancers is better than for chronic scar cancers, although the conditions attending the former type are more favorable for rapid growth and dissemination. This more favorable outcome may be attributed to the superficial character of the scars, the small size of the lesions, and the predominance of basal cell types, which are much more amenable to radiation therapy.

A plea is made for adequate, satisfactory, and aggressive treatment of burns. Here is a definite field for cancer prophylaxis. Burns should be prevented, local treatment should be instituted to prevent infection of the burned area, once the damage is done. The burn scar should be properly cared for and measures adopted which will promote rapid epithelization. Early skin grafting should be employed where repair is slow or in cases in which the surgeon feels an excess of scar tissue will develop. Lastly, a radical excision of the scar should be performed when persistent ulceration is present or degenerative changes appear.

In burns of a severe degree skin grafting is the most efficient preventive measure. When skin grafting is delayed, unhealthy granulations with a scar tissue base develop. It is important to employ skin grafting in the burns sustained by children, not only for cosmetic and functional results but because the exuberant scars which form in young individuals are more prone to degenerate later in life. The types of skin grafts to be used will depend upon the severity, extent, and location of the burn.

Scars which have formed, especially large ones, are menaces. They must be safeguarded against irritation and trauma. If dry they should be occasionally treated with a bland oil or ointment to prevent excessive keratin accumulation.

Radiation therapy, especially the use of heavily filtered radium at a distance, should be the first form of treatment for these epitheliomata. The small lesions, and particularly the basal cell lesions, will usually disappear after adequate irradiation. Radiation failures may be due to the type of squamous cancer occurring in burn scars which is a highly differentiated adult neoplasm. These epitheliomata have inadequate blood supplies and the tissue reaction and process of repair are weak or absent in the scar bed. Infection which is present interferes with successful irradiation. Four latent scar cancers and four acute wound cancers were cured by irradiation alone, and in two other instances this form of therapy was adequate after surgery had failed. If radium is not available, a wide local excision or destruction with the actual cautery may suffice. Curettage is inadvisable.

If the lesions are radioresistant, surgical intervention becomes necessary and the magnitude of the procedure will depend upon the location and extent of the lesion. Local excision of well developed scar cancer is unsuccessful and dangerous. The failure in such instances is due to the fact that the operations were not radical enough and that few of the cancers received pre-operative irradiation.

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## CARCINOMA OF THE RECTUM

## A STUDY OF THREE HUNDRED THREE CASES

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CANCER of the rectum and sigmoid, which comprises about three-fourths of the malignancy of the intestinal tract and which has been variously estimated as including between four and sixteen per cent of all cancers, has been the subject of investigation for many years. It was with the idea of throwing a little more light on the course of the disease and of emphasizing the indications for radical or palliative therapy, that the authors were prompted to undertake the study of the cases of this condition seen at the Collis P. Huntington Memorial Hospital.

During the last few years, numerous articles have been written which have emphasized some particular phase of treatment, such as operation or radium therapy. We, therefore, deemed it worth while to gather together for review a large number of cases treated in various ways and to record their progress as far as is possible, taking the cases consecutively and classifying them.

Between May, 1912, and January, 1928, 303 patients entered the hospital with a clinical diagnosis of carcinoma of the rectum. All these cases have been included in our paper, but no case has been accepted as a cure unless a pathological examination was made of the tissue removed at operation or at biopsy.

In reviewing the records, it soon became evident that we should emphasize two factors influencing our decision as to treatment: (1) whether there was previous operative therapy, and, if employed, whether it was radical or palliative, (2) our clinical impression as to whether the case was relatively favorable or unfavorable for cure or length of life.

To that end we devised an abstract record sheet modeled on those of the American College of Surgeons already in use for tabulating cases of carcinoma of the breast, cervix, and buccal cavity. We then offered it to the American College of Surgeons, feeling that if the various clinics studying cancer of the

rectum would record their cases on this type of card, it would greatly simplify the total grouping of the disease throughout the country. This card has been accepted by the College.

Under the heading, "Classification," (Fig. 1, B) it will be noted that the cases fall into the two main groups suggested. Under the sub-headings, 1, 2, and 3, we have placed respectively the cases that have had no previous operative therapy, radical therapy, or palliative therapy, and under the letters A to G we have attempted to indicate the criteria for gauging their prognosis. We intend to elaborate more fully upon our conception of the terms "radical" and "palliative" later in the main body of the paper, for we have very definite ideas as to what form of therapy will give a patient the best chance of cure. It was decided not to make a separate classification for the cases that had radium, X-ray, or other non-operative therapy *previous* to entering the hospital, as there were too few of these cases to warrant grouping. Furthermore, we were unable to obtain exact data as to technique of application of the radiation. This subject we will, however, take up later under the heading, "Treatment before Entrance."

Decision as to whether a case shall be placed in group A or B is, of course, difficult, for it is sometimes almost impossible to estimate the depth of penetration of a growth through the bowel wall. Also, we wish to emphasize that in cases placed in group C, the prognosis varies tremendously according to whether the fixation of the bowel is due to extension of growth into perirectal tissue or to inflammatory changes.

## ETIOLOGY

In some of these cases there is a history of previous chronic inflammatory lesions, but the number is not convincing or the connections at all apparent. We agree with Daniel F. Jones who says "It is useless to state that





TABLE I—PRE-EXISTING RECTAL PATHOLOGY.

	Occurrence Cases per cent	
Hemorrhoids	89	29
Constipation	90	29
Dysphoria	65	21
Fistula	6	2
Stricture	1	33

TABLE II—AGES AND SEX

Age in years	Males	Females
10 to 20	0	1
21 to 30	2	1
31 to 40	8	8
41 to 50	37	24
51 to 60	55	41
61 to 70	53	24
71 to 80	22	16
81 to 90	0	4
91 to 100	0	1
Not given	2	4
Total	179	124

The average age of males was 57 years, no age given in 2 cases. The average age of females was 49 years, no age given in 4 cases. Total number of cases 303.

stipation is so common an ailment that it can hardly be considered as an important etiologic factor, though it may well play some part in causing irritation of adenomatous areas.

Just as in cancer of the skin and buccal mucous membrane, we recognize keratoses and leucoplakia as being definitely precancerous lesions, so in the rectum adenomatous polyps constitute the most dangerous predisposing factor in the development of adenocarcinoma here. Mummery, Dukes, Jones, Rankin, Yeomans, and others have written convincingly on this point. We have had no opportunity actually to observe this transition in a particular polyp in any case, and the patients in this series were not under observation before the growth itself was detected. Adenomata do occur in the areas most frequently involved in cancer and by their structure could, and undoubtedly do, undergo malignant degeneration. (See under "Pathology.") That cancer and polyps may co-exist in the same area is a matter of common observation, and is clearly shown in Figure 2. Case 116 in our series presented similar pathology. Yeomans quotes two series, totaling 61 cases, of Doering and Soper, in which adenocarcinoma developed in 26 cases. Tuttle reported 8 cases of multiple polyposis with adenocarcinoma in 5 of them. Mummery cites a case in which 3 entirely separate areas



Fig. 2. Annular carcinoma superimposed on a multiple polyposis of the rectum and sigmoid (a case operated on by Dr. Edward P. Richardson).

of carcinoma occurred in the rectum. One of us (W.M.S.) recently removed a rectum with two distinct and separate areas of carcinoma co-existing with multiple polyps.

#### AGE

Our figures agree with those of other clinics which show the greatest number of cases in the fifth decade of life. We had, however, in our hospital a girl of 18 years with a clinical diagnosis of carcinoma of the rectum. No biopsy was done, but she died with what was apparently carcinoma of the rectum, and her death certificate was signed with that diagnosis.

The youngest female on whom we have a definite pathological report was 34 years.

The youngest male case with a definitely proved diagnosis was 26 years. Allingham, quoted by Meckling, reports a case of a boy of 13 years, and Pennington mentions 3 cases at the age of 11 years.

We have 1 female of 92 years with a clinical diagnosis of carcinoma of the rectum, another of 81 years with a definite pathological report of carcinoma, and a man of 83 years also with a definite report. (See Table II.)

#### SEX

There were 179 males and 124 females (See Table II.)

#### FAMILY HISTORY

Only 12 cases, or 7 per cent, of 177 (i.e., the cases about which we have known data) gave a history of cancer in the immediate family.

TABLE III—FAMILY HISTORY OF CANCER

	Per cent	Cases
Negative to carcinoma	93	165
One parent died of carcinoma in 11 cases other members of family were affected in 1 case		
Total	7	12
Region affected		
Gastro-intestinal tract—rectum	2	stomach 4
intestine	4	10
Other regions		2
Number of cases with known data		177
Number of cases with no data		126
Total number of cases		303

To date there is too little definite material on hand regarding heredity as a factor in this disease for us to do more than present this table of figures (See Table III)

Mummery, quoted by Pennington, gives a history of three families, the members of which had adenomatosis for several generations. A large number of them died of cancer of the rectum, many of the patients at a comparatively early age.

There were, for instance, 7 between the ages of 27 and 54 years. It is felt by most of those who have investigated family incidence that the frequency of carcinoma in the families studied is no greater than that in the populace at large.

#### PATHOLOGY

By far the greater number of malignant tumors of the rectum are glandular carcinomata. Next in frequency, but far behind in numbers, come the squamous cell or epidermoid carcinomata. Sarcoma and lymphoma are met with rarely. We have found no sarcomata but have seen two proved lymphomata since this series was closed. There are positive pathological reports on only 143 cases—or 47 per cent of the entire series. In the earlier years, specimens were not excised as frequently for diagnosis, probably because of the fear of accelerating spread of the disease by so doing. The feeling, of late, has been that biopsy of a growth, by definitely establishing the diagnosis and permitting a grading of the degree of malignancy, has advantages that more than outweigh any possible stimulation of the growth by the cutting, for cauliflower-like, ulcerated, nodular, fixed tumors of the rectum are not always car-

TABLE IV—DEGREE OF MALIGNANCY

	Grade	No. Cases	Per cent
Epidermoid carcinoma	1	3	3
Epidermoid carcinoma	2	5	5
Epidermoid carcinoma	3	1	1
Malignant adenoma		57	57
Adenocarcinoma	1	18	18
Adenocarcinoma	2	10	10
Adenocarcinoma	3	2	2
Colloid	4	1	1
Malignant adenoma and adenocarcinoma	1	3	3
Adenocarcinoma	1 and 2	1	1
Total		101	

cinomata, as is illustrated by the following case history from our series. A man of 36 was operated upon with the diagnosis of cancer of the rectum. It was decided on opening the abdomen that the tumor was inoperable as it was firmly fixed in the pelvis. A colostomy was performed and he was treated with radium. To the surprise of all the large tumor disappeared. The original section of the tumor was reviewed microscopically. Dr J. Homer Wright then made the diagnosis of angiomatous polyposis. It is now 5 years since his laparotomy and so far there has been no sign of recurrence. Obviously the fixation was inflammatory.

Our tumors, in so far as slides are at present available (101 cases), have been carefully grouped, as to degree of malignancy, based on a classification slightly modified from that of Broders, as shown in Table IV.

Warren groups as "malignant adenomata" those tumors showing large glandular structures, similar in size and appearance to benign adenomata, and undoubtedly derived therefrom. He recognizes, also, that in some cases where section from the surface of a tumor shows "malignant adenoma," a section nearer the base may show the typical small glandular structure of adenocarcinoma. Three cases in our series illustrate this point.

The malignant adenomata are usually low grade, while the adenocarcinomata show more variation. Of the malignant adenomata, 6 were on the borderline of simple adenomatous polyps.

The value of this classification lies, to a large extent, in its prognostic importance. Under similar methods of treatment one expects the least malignant cases to survive

TABLE V—SYMPTOMS FIRST NOTICED BY THE PATIENT

	Percent No cases	
Common symptoms		
Bleeding alone	12	39
Bleeding and diarrhoea	4	14
Bleeding and constipation	3	10
Bleeding, constipation, pain	2	8
Bleeding, diarrhoea, pain	1	5
Total bleeding	22	76
Rectal pain alone	17	52
Rectal pain and other symptoms	12	37
Tenesmus and other symptoms	4	12
Total rectal pain	33	101
Constipation alone	4	12
Constipation and other symptoms	13	40
Total constipation	17	52
Diarrhoea alone	2	6
Mucus in combination	3	11
Back pain and other symptoms	5	16
Uncommon symptoms		
Mucus alone	1	1
Pain in penis with other symptoms	1	1
Back pain alone	2	2
Incontinence of feces in combination	1	3
Urinary frequency in combination	3	6
Dysuria in combination	1	1
Pruritus alone	2	2
Pruritus combined	1	1
Abdominal pain alone	1	1
Abdominal pain in combination	2	2
Mass in groin alone	1	1
Mass at anus alone	1	1
Abdominal mass alone	1	1
Vaginal bleeding in combination	2	2
Ulcer at anus	1	1
Indigestion in combination	1	1
Fistula in combination	1	1

longest The results in our series cannot be correlated too closely with the pathological grouping because these cases were so advanced when first seen here that no therapy was of much avail

It is most encouraging to note that 57 per cent of the tumors fall into the class of malignant adenomata, the least malignant of all the grades Twenty per cent are Grade I adenocarcinomata, totaling 77 per cent of the entire number which can be placed in the two lowest grades of malignancy This bears out and explains to a considerable extent the fact that cancers of the rectum are relatively slow growing and tend to remain localized in the bowel for a considerable time before they break through the fascia propria and invade the adjacent and more distant areas of

TABLE VI—SYMPTOMS DEVELOPING DURING PRESENT ILLNESS

	Per cent	Cases
Blood	65	197
Pain (rectal)	61	187
Loss of weight	53	163
Constipation	50	152
Tenesmus	15	47
Frequent stools	15	47
Flatus	7	22
Abdominal pain	5	16
Urinary—		
Dysuria	less than 1	1
Frequency	less than 1	2
Nocturia	less than 1	3
Retention	less than 1	2
Difficulty starting	less than 1	2
"Bladder trouble"	less than 1	1
Total urinary	4	11
Loose stools	2	7
Vomiting or nausea	less than 1	3
Rectal incontinence	less than 1	3
Obstructive (early symptoms)	less than 1	2

metastasis With this knowledge we are encouraged to attempt radical operation as often as there seems any likelihood of success and also in some instances where rectal examination is not too favorable Although we have available for grouping pathological slides in only a third of the total cases, nevertheless it is reasonable to expect that the percentages here recorded represent a fair cross section of this series and of cancers of the rectum at large

Knowledge that the malignancy is low in a certain case may well encourage the surgeon to operate even when the growth seems large and somewhat fixed Fixation may be inflammatory and a cure is entirely possible Conversely, when the malignancy is high and the patient perhaps a questionable operative risk, the grading may be the factor which decides the surgeon against operating

The epidermoid carcinoma originates at, or close by, the mucocutaneous junction and spreads both upward into the lower rectum and outward on to the buttocks There is a rich, subcutaneous lymphatic network around the anal opening which communicates freely with the lymphatics in the muscular coat of the lower rectum, by way of channels in the columns of Morgagni, while communication with the anorectal nodes is also quite free Thus is explained the ease with which a

TABLE VII—LOWER LIMIT OF GROWTH ON  
ADMISSION TO HOSPITAL

	Per cent	Cases
At anus and just above anus	18	56
1 to 4 centimeters	18	55
5 to 7 centimeters	20	61
8 to 10 centimeters	17	117
11 to 16 centimeters	5	16
Known data		299
No mention		4
Total		393

TABLE VIII—CIRCUMFERENTIAL INVOLVE-  
MENT ON ADMISSION TO HOSPITAL

	Per cent	Cases
Annular	41	117
Three fourths of circumference	34	95
Anterior alone	15	43
Posterior alone	8	22
Right lateral alone	1	3
Left lateral alone	1	3
Known data		283
No mention		20
Total		393

growth at the mucocutaneous junction extends upward into the rectum. Likewise there is free communication subcutaneously from the adjoining skin outward in the furrow between thigh and abdomen to the inguinal nodes, and metastases here occur relatively early. It will be clearly seen that a wide local excision if done at all, must be done very early if it is to be successful. To decide whether a wide local excision of an easily accessible early growth at the anal margin is a safe gamble is a very difficult matter. The alternative is, of course, colostomy and posterior excision of rectum, together with bilateral groin dissection.

Glandular carcinoma, developing as it does from the mucous membrane within the rectum, pursues a different course both as to direct spread and as to metastasis. It starts as a small circumscribed nodule or ulcer and spreads more rapidly around the gut than it does longitudinally, becoming annular in about a year's time. It metastasizes in three zones—upward, laterally, and downward. The growth may invade all of these zones, but if situated low in the rectum it will invade the ischio-rectal fat and levators earlier than if situated high. In the same way, a high growth will metastasize upward to the iliac glands

TABLE IX—FIXATION OF GROWTH ON  
ADMISSION TO HOSPITAL

	Per cent	Cases
Fixed in some degree—	86	135
Fixed in more than one quadrant	33	52
Posteriorly alone	17	27
Anteriorly alone		
To vaginal septum	25	
To prostate	12	
Anteriorly	15	
To bladder	4	
Total anterior	36	56
Not fixed	14	22
Total known data		157
No mention		146
Total		393

earlier than will a low growth. Liver invasion is presumably blood borne and may be expected sooner or later from any rectal growth.

#### SYMPTOMS AND DIAGNOSIS

An understanding of the pathology and mode of spread of the disease makes clear the symptomatology. Ulceration comes early, therefore bleeding and the discharge of pus and mucus are early symptoms. As the growth progresses and secondary inflammation becomes more pronounced, pain may appear and the frequency of rectal discharge is increased. This results in irritation of the region of the sphincter and the tenesmus which often occurs. Obstructive symptoms are infrequent and are always late symptoms, though occasionally earlier warnings are ignored and the patient consults a doctor only with the onset of obstruction. In our series, there were only two cases in which there would seem to have been definite partial obstruction when they first came to the hospital. It occurs usually in tumors at the rectosigmoid junction because this is the narrowest part of the rectum. Constipation was a primary symptom in 17 per cent of the series, but we do not classify these cases as "obstructed" since they did not have colic like pain or distention. A variety of other first symptoms, occurring in a few cases, was met with in going over the records. A classification of primary symptoms in our series is given in Table V.

Many more early diagnoses would be made if doctors more generally could be brought to appreciate the possible and, indeed, the probable significance in a particular individual of a

TABLE X —ADMISSION EXAMINATION—SIZE OF LUMEN ON ADMISSION TO HOSPITAL

	Per cent	Cases
Nearly normal	19	27
Admits index finger	50	71
Very small	30	42
Known data		140
No mention		163
Total		303

TABLE XI —ENTRANCE EXAMINATION—INGUINAL NODES

	Per cent	Cases
Not abnormal	91	146
"Hard"	7	12
"Enlarged"	2	3
Known data		161
No mention		142
Total		303

It will be noted in this table that in only 9 per cent of the case were the inguinal nodes in any way suspicious. We have had in our series only one biopsy of inguinal glands with a pathological diagnosis of cancer.

change in his or her normal bowel function when that change has persisted more than a week or two. Because bleeding is so common a symptom of internal piles, doctors too often make a snap diagnosis along these lines. Thus, in our series, upon admission to the hospital, 34 patients said they had bleeding piles, 24 others had been receiving medical treatment on that assumption, and 20 others had been operated on for hemorrhoids comparatively recently. A goodly number of these probably did have hemorrhoids, but they had cancer also. A visiting doctor recently remarked, when someone emphasized rectal bleeding as a symptom of cancer, "Down our way we look for horses, not for unicorns." True enough, but one ought to be able to recognize a unicorn when it appears.

With early cancer of the rectum, the general practitioner usually sees a healthy appearing individual who comes in because he has seen a little blood in his movements or he has had a little rectal discomfort, or some increase in constipation or a tendency to move his bowels a little more often than usual. As a rule he has one or two formed movements a day and perhaps several additional stools of only pus, blood, and mucus. A diagnosis correctly made early gives the opportunity for radical operation and cure. Steps in diagnosis should include, in the order named

TABLE XII —METASTASES TO LIVER

	Per cent	Cases
Liver not palpable	87	130
Nodule palpable	5	7
Enlarged abnormally	8	12
Known data		149
No mention		154
Total		303

Metastases in the liver are not commonly detected on physical examination as can be seen in this table. In only 13 per cent was the liver thought to be abnormal. In some cases the abnormal enlargement may have been simply ptosis.

TABLE XIII —GENERAL APPEARANCE ON ADMISSION TO HOSPITAL

	Per cent	Cases
Well nourished	69	122
Poorly nourished	26	46
Obese	5	8
Known data		176
No mention		127
Total		303

Pallor was noticed in 22 cases of only 68 in which any mention was made of patients' color.

Loss of weight was apparent in 27 cases of the 90 in which any mention was made of weight.

Distention was present in 34 cases of only 64 in which any mention was made. In looking over these records there was nothing else to indicate that intestinal obstruction was present, and we are inclined to believe, therefore, that they were not really obstructed.

- 1 Careful history (see American College of Surgeons' card),
- 2 Digital rectal examination as high as possible,
- 3 Speculum examination of anal canal,
- 4 Proctoscopy 2 to 3 hours after cleansing enema,
- 5 Barium enema only if proctoscopy is negative.

The firm induration of carcinoma, so unlike the normal elasticity of the rectal wall, is so characteristic that it is hard to understand the failure of some doctors to recognize it. Finger examination is the most important single factor in diagnosis. It is very essential to sweep the finger over every square inch of the ampulla of the rectum and to insinuate the finger past the valves to as high a point as possible. The proctoscope permits observation beyond the tip of the finger and the barium enema is of use beyond the tip of the long sigmoidoscope. The barium enema is very unreliable in the diagnosis of growths in the rectum and lower sigmoid. We wish to emphasize that in this series 95 per cent of the

TABLE VII—LOWER LIMIT OF GROWTH ON  
ADMISSION TO HOSPITAL

	Per cent	Cases
At anus and just above anus	18	56
1 to 4 centimeters	18	55
5 to 7 centimeters	20	61
8 to 10 centimeters	37	111
11 to 16 centimeters	5	16
Known data		290
No mention		4
Total		303

TABLE VIII—CIRCUMFERENTIAL INVOLVE  
MENT ON ADMISSION TO HOSPITAL

	Per cent	Cases
Annular	41	117
Three fourths of circumference	34	95
Anterior alone	15	43
Posterior alone	8	22
Right lateral alone	1	3
Left lateral alone	1	3
Known data		283
No mention		10
Total		303

growth at the mucocutaneous junction extends upward into the rectum. Likewise there is free communication subcutaneously from the adjoining skin outward in the furrow between thigh and abdomen to the inguinal nodes, and metastases here occur relatively early. It will be clearly seen that a wide local excision if done at all, must be done very early if it is to be successful. To decide whether a wide local excision of an easily accessible early growth at the anal margin is a safe gamble is a very difficult matter. The alternative is, of course, colostomy and posterior excision of rectum, together with bilateral groin dissection.

Glandular carcinoma, developing as it does from the mucous membrane within the rectum, pursues a different course both as to direct spread and as to metastasis. It starts as a small circumscribed nodule or ulcer and spreads more rapidly around the gut than it does longitudinally, becoming annular in about a year's time. It metastasizes in three zones—upward, laterally, and downward. The growth may invade all of these zones, but if situated low in the rectum it will invade the ischio-rectal fat and levators earlier than if situated high. In the same way, a high growth will metastasize upward to the iliac glands

TABLE IX—FIXATION OF GROWTH ON  
ADMISSION TO HOSPITAL

	Per cent	Cases
Fixed in some degree—	86	135
Fixed in more than one quadrant	33	57
Posteriorly alone	17	27
Anteriorly alone		
To vaginal septum	25	
To prostate	12	
Anteriorly	15	
To bladder	4	
Total anterior	36	56
Not fixed	14	21
Total known data		157
No mention		146
Total		303

earlier than will a low growth. Liver invasion is presumably blood borne and may be expected sooner or later from any rectal growth.

## SYMPTOMS AND DIAGNOSIS

An understanding of the pathology and mode of spread of the disease makes clear the symptomatology. Ulceration comes early, therefore bleeding and the discharge of pus and mucus are early symptoms. As the growth progresses and secondary inflammation becomes more pronounced, pain may appear and the frequency of rectal discharge is increased. This results in irritation of the region of the sphincter and the tenesmus which often occurs. Obstructive symptoms are infrequent and are always late symptoms, though occasionally earlier warnings are ignored and the patient consults a doctor only with the onset of obstruction. In our series, there were only two cases in which there would seem to have been definite partial obstruction when they first came to the hospital. It occurs usually in tumors at the rectosigmoid junction because this is the narrowest part of the rectum. Constipation was a primary symptom in 17 per cent of the series, but we do not classify these cases as "obstructed" since they did not have colic like pain or distention. A variety of other first symptoms, occurring in a few cases, was met with in going over the records. A classification of primary symptoms in our series is given in Table V.

Many more early diagnoses would be made if doctors more generally could be brought to appreciate the possible and, indeed, the probable significance in a particular individual of a

TABLE XVII—ADVICE AND TREATMENT RECEIVED ELSEWHERE

	Per cent	Cases
1 Referred to Huntington Memorial Hospital without advice	19	45
2 Colostomy or radical excision with or without radium	21	59
3 Operation or treatment for hemorrhoids	16	38
4 Radium or X ray advised	10	25
5 Medicines prescribed for intestinal troubles	10	25
6 Suppositories and ointments advised	8	19
7 Local operation advised	4	9
8 Serum, electrical and osteopathic treatments, etc. advised	4	9
9 Operation for fistula advised	1	3
10 Expectant treatment advised	less than 1	2
11 X ray examination advised	less than 1	1
12 Treatment for rectal ulcer advised	less than 1	1
Known data		236
No mention		67
Total		303

This idea must be dissipated if we are going to treat patients operatively early enough to get a cure. The patient must be advised that he or she can live comfortably, both physically and socially, with a colostomy, and that only by attacking the growth vigorously and excising widely can we hope for a cure.

It is rather interesting to note that only 19 per cent of the cases in which we have data (236) arrived without having been subjected to some form of incomplete therapy or given advice along other lines (Table XVII, item 1). To be sure there were another 21 per cent who had been urged to submit to operation, but in many of these it was colostomy only that had been advised.

One explanation as to why inadequate therapy is employed is that the doctor has not, in many instances, made the diagnosis. Often he has made an incomplete rectal examination, or, in many instances, none at all. This is illustrated by the fact that 16 per cent of our cases were treated for hemorrhoids alone (Table XVII, item 3), without the doctor suspecting that only a short distance above the hemorrhoids lurked a neoplasm.

We have stated above, and again state here, that, as yet, radium does *not* give the patient the best chance of cure. It is a common

TABLE XVIII—OUTLINE OF TREATMENT GIVEN AT HUNTINGTON MEMORIAL HOSPITAL

	Per cent	Cases
<b>Radiation</b>		
Radium alone	25	76
Radium and colostomy	15	46
Radium and X ray	3	9
Radium X ray, and colostomy	2	7
X ray alone	less than 1	2
Total radiation	46	140
<b>Radical operations</b>		
Radical operation only	17	50
Radical operation and radium	4	13
Total radical operations	21	63
Colostomy alone	4	14
Exploratory laparotomy	1	3
No treatment advised	14	42
<b>Treatment advised and refused—</b>		
Radical operation	1	4
Radium alone	2	5
X ray alone	less than 1	2
Colostomy alone	1	3
Radium and colostomy	less than 1	1
Insufficient data	9	26
Total cases		303

experience to have a patient say, "My doctor told me that we would try radium for a while, and if that did not work we would then talk operation." Twenty-five patients were so advised before they came to the Huntington Hospital.

Suppositories and ointments were prescribed in 8 per cent of our cases—probably on the supposition that hemorrhoids or fissure were being dealt with. Perhaps these lesions were actually present, but with *carcinoma co-existent*.

If operation is advised it should be nothing short of a complete one, which means almost without exception that a colostomy will have to be included. We are glad to note, therefore, that in only 4 per cent of the cases did the doctor, knowing it was cancer, advise a local excision.

Item 8 in Table XVII can be dismissed without much comment, as the readers of this article undoubtedly will agree that with our present knowledge of cancer, to advocate such inadequate therapy of cancer of the rectum is certainly in the realm of quackery. It is not that the treatment *per se* is harmful—it usually is not—but that precious days and weeks are wasted while the growth advances unchecked.



TABLE XIV.—NOW LIVING WITHOUT SYMPTOMS—RADICAL OPERATIONS

Time since operation in years	Our classification	Pathological report	Type of operation
11½	1C	Adenocarcinoma grade 2	Abdominoperineal 1 stage
10	1A	Malignant adenoma	Abdominoperineal 2 stage
9	3B	Malignant adenoma	Colostomy and posterior excision
8	1A	Adenocarcinoma grade 2	Abdominoperineal 2 stage
7	1C	Malignant adenoma	Abdominoperineal 2 stage
7	1D	Epidermoid carcinoma grade 2	Colostomy and posterior excision
7	1C	Adenocarcinoma grade 2	Abdominoperineal 2 stage
6	1A	Epidermoid carcinoma	Colostomy and posterior excision bilateral groin dissection
6	1A	None	Perineal resection alone (?)
5	1A	Adenocarcinoma	Abdominoperineal 2 stage
5	1B	Adenocarcinoma	Colostomy and posterior excision
5	1A	Adenocarcinoma grade 1	Colostomy and posterior excision
5	1C	Adenocarcinoma grade 2	Abdominoperineal 2 stage
5	1C	Malignant adenoma tuberculosis adjacent nodes	Abdominoperineal
3	1C	Malignant adenoma	Abdominoperineal 2 stage
3	1A	Malignant adenoma	Abdominoperineal 2 stage
3	1A	Adenocarcinoma grade 2	Abdominoperineal 2 stage
3	1A	Adenocarcinoma grade 2	Abdominoperineal 2 stage
3	1B	Epidermoid carcinoma grade 3	Colostomy and posterior excision
3	1A	Malignant adenoma	Not known
2	1B	Malignant adenoma	Abdominoperineal 2 stage

In 3 cases operation for fistula was advised. An ordinary anal fistula may exist with a cancer and with neither related to the other. Likewise, a carcinomatous fistula may develop secondary to a growth low in the rectum.

In 2 cases the doctor advised "expectant treatment," though what benefit was expected to issue from this is hard to understand.

One case was advised to have an X-ray examination. We assume this was a barium enema. We have indicated already that X-ray with cancer of the rectum below 15 to 20 centimeters from the anus is notoriously uncertain. The diagnosis of cancer of the rectum may be made with the finger in 95 per cent of the cases.

One case had a rectal ulcer which was treated locally. Any ulcer persisting over 2 weeks must be looked upon with suspicion. Biopsy can be done at any time with safety.

#### DETERMINATION OF TYPE OF TREATMENT

**Radical operation.** Cancer of the rectum, though insidious in its onset, has the redeeming feature of remaining localized to the bowel for a considerable period. Just how long this is, one cannot say with any certainty, but probably in some cases even as long as a year. Furthermore, as has been pointed out previously, about 77 per cent of these tumors are of the two lowest grades of malignancy. Therefore, if we can get the patient early, and if he will consent to have an adequate operation performed, his chances of a permanent

cure are very good. In this series, unfortunately, only 69 cases were considered as at all favorable for operation, and 63 of these submitted to a complete operation. Of this number many were borderline cases as to operability. Had they been seen 6 to 12 months earlier the outcome might have been different. These cases were operated upon by various surgeons, a few by ourselves and the majority by Dr. D. F. Jones.

What, then, constitutes a proper operative procedure? The result to be achieved is constant, the technical procedure varies somewhat with the location of the growth. Removal of the entire rectum with the growth and a margin of several inches of normal bowel above must be accomplished. The specimen should include, intact, the following structures, the anus and a wide ellipse of skin around it, a wide removal of ischioanal fat, the entire levatores, all retrorectal tissue including mesosigmoid up to the point of branching of the left colic artery from the inferior mesenteric. The dissection should go laterally to the ureters, and should be limited anteriorly only by bladder and prostate or vagina, and posteriorly by the sacrum. Colostomy is always necessary. The combined abdominoperineal operation, either in one or two stages, as described by Miles, Jones, Coffey, Rankin, and others, is the ideal procedure. Mummery uses simple colostomy and a wide, high posterior excision more generally than would seem wise, but this is an

excellent operation for low growths and early ones. The operation of Hartmann is very useful for a high growth, the dissection being carried abdominally below the tumor, and resection done here, inverting the rectal stump to be later excised. The surgeon must have at his command four or five procedures, each suited to a certain situation, but all of a magnitude which accomplishes wide removal of growth and gland bearing areas. These operations have all been clearly written up, and it is superfluous to describe them again in this paper.

*Cases now living after radical operation.* Of the 63 cases in this series who had radical operations performed, 21 are now, December, 1929, living after varying periods of time (Table XIX). Although a pathological report is lacking in 1 of this group, the descriptions of the growth and opinions expressed lead us to think that it was undoubtedly cancer. In the 3 epidermoid carcinomata it will be noted that colostomy and posterior excision were performed. This, of course, is a logical procedure because there is not a great chance of the higher iliac nodes being involved. In one of these cases bilateral groin dissection made the chance of cure greater, and it should be carried out in all epidermoid cases. The abdominoperineal operation was done in 13 cases, colostomy and posterior excision in 6. The latter were all low growths with one exception. In 2 cases the exact type of operation could not be ascertained. Our classification shows 10 1A, 3 1B, and 6 1C cases. In other words, 14 of the 22 were considered to have movable growths and to be good prospects for radical removal, and the results have justified the procedure. It is of interest that the 6 1C cases are also cures, suggesting that their fixation was probably inflammatory rather than due to extension of growth. Of the two remaining cases, one is a 9 year cure with colostomy and posterior excision after a hæmorrhoid operation from which a pathological report of adenocarcinoma resulted. The last case was an epidermoid carcinoma, and the patient was operated upon previously with a diagnosis of hæmorrhoid. He is now a 7 year cure following colostomy and posterior excision.

TABLE XX.—RADIATION THERAPY

	Per cent	Cases
1 Radium alone	55	76
2 Radium and colostomy	33	46
3 Radium and X ray	6	9
4 Radium and X ray and colostomy	5	7
5 X ray alone	1	2
Total		140

*Cases now dead after radical operation.* Of the 63 cases operated upon radically, 41 are dead. Three of these were operative fatalities and a fourth died one month later. (This does not represent a true operative mortality as some of these cases came to us after operation elsewhere.) Most of the others died with recurrent malignant disease, we know, and the remainder in all probability did. This group, exclusive of the operative fatalities, survived an average of 2 years and 4 months after operation. One case survived 7 years and died of recurrence. He had an abdominoperineal operation following a previous incomplete operation. The pathological report was malignant adenoma, and he was treated with radium also. Three cases lived 5 years or slightly over. All died with carcinoma present. One case, a *colloid* carcinoma surviving operation only 6 months, showed on postmortem examination metastases in the heart, lungs, gall bladder, adrenals, intestine, and stomach. The liver was not mentioned. Of the types of operation which were performed, 15 were colostomies with posterior excision, there were 22 abdominoperineal operations, there was one Harrison-Cripps operation, and 3 were uncertain.

*Radium and X-ray treatment.* Of the 76 cases treated by radium alone (Table XVIII) there were 29 (38 per cent) grouped clinically as 1A—that is, they had had no previous treatment and it was felt that the prognosis for cure would be good if the radical operation were done. They received radium either because they refused, or their general condition precluded, operation. The growths in these cases were not fixed to the surrounding tissue and there was no palpable evidence of metastases. Of the 29, 24 are dead of cancer. They survived an average of approximately 20 months from the time of entrance—the longest duration being 3 years and 10 months.

and the shortest 1 month. We have recently (December, 1929) reviewed the 5 cases living in January, 1928, and also checked over the pathological specimens. One case is well 4 years after she entered the hospital but our present pathologist, Dr Shields Warren, feels that the original report of malignant adenoma was an error and that the growth should have been called a benign adenoma. A second died 2 years and 5 months after entrance with no clinical evidence of cancer. The pathologist states that the growth was *borderline between polyp and malignant adenoma*. The 3 others cannot be classed as cures as we have no pathological reports. One is living 6 years after entrance. The original growth was described as papillary, about 2.5 centimeters in diameter and about 7 centimeters from the anus. A second case had a growth 3.5 centimeters in diameter, an indurated, firmly fixed ulcer 8 centimeters from the anus. This patient is living 7 years after entrance. A third Dr D. F. Jones believed to be cancer and was located about 8 to 10 centimeters from the anus. She is living 10 years after entrance.

In the earlier cases treatment consisted of surface application. Later glass "seeds" were used but for the past 3 years we have been employing only metal "seeds," the screening in these being 0.3 millimeters of gold. Through a trocar we embed them in the growth. We have been using the gold seeds too short a time to warrant a statement as to results, but we are encouraged to persist in their use by the fact that the patients have much less local reaction and can thus be treated with much heavier dosage. The results of the treatment with gold seeds and with diathermy we hope to report in a later paper.

In the 1B group, that is, those in which the growth had penetrated the bowel wall but had as yet not invaded the perirectal tissue, there were 21 cases, 27 per cent of all those treated with radium. The average time these patients survived was 11 months from the time of entrance, the longest duration being 2 years and 8 months, and the shortest, 1 month. None of them is now alive.

As we have stated elsewhere in this paper, 77 per cent of the tumors were of a low degree

of malignancy (i.e., malignant adenomata or adenocarcinomata, grade 1).

It is agreed that the lower the degree of malignancy the less radiosensitive is the tumor. Therefore it is not surprising that these carcinomata of the rectum have responded only feebly to the doses that we have been able to give.

Carter Braine, of Guys Hospital, London, states that "intracavitary application has failed deplorably except in conjunction with other methods." We would agree with this heartily.

Pennington describes the experiences of a few of the clinics which are using radium on a relatively large scale in treating cancer of the rectum. Lécene had but mediocre results. Kuettnner saw remarkable benefits in some instances, others were unchanged, some improved for a time only, and still others seemed to be made worse. Quick treated 160 cases with radium. A large number were benefited from 1 to 3 years. The oldest ones were of 4 years' standing. The number of cures is not stated.

The remainder of the group treated by radium were those obviously too far advanced to treat other than palliatively. There were 26 such cases and if we add the 39 advanced cases, handled with radium plus a colostomy, and the ones which had radium and X ray, we have a total of 83 (61 per cent of all those treated with radium). It is this group that constitutes a real problem for the man employing radiotherapy. Many were benefited symptomatically by a reduction in the size of the tumor, for with the removal of part of the sloughing mass, there is a consequent reduction in the area of secondary infection and rectal tenesmus is often thus brought to a minimum.

It is probable, however, that surgical diathermy will supplant to a great extent radium used as a palliative measure. We have employed it in a few instances and think it has definite possibilities.

There is one very obvious disadvantage in attempting to treat an annular tumor from below, namely that if the lumen of the growth is small, only its lower border can be attacked. The growth can occasionally be attacked from

above by passing a small proctoscope down through a colostomy and embedding seeds through a trocar. There are two definite objections to this technique. The first is that usually only the upper border can thus be approached and the second is that there is a certain amount of danger in exerting leverage on the gut with the instrument.

Interstitial needling as performed by Neumann and Coryn of the Radium Institute of Brussels and described by Ogilvie seems to be a fairly effective technique. They report 4 3-year cures out of 9 cases which we would probably class as 1A. They also had 4 3-year cures out of 28 inoperable (1C) cases. These combined give a 3-year cure figure of 20 per cent. No pathological reports are mentioned. Their original paper appeared in the European journal *Cancer*, published in Brussels in 1927 and is not available to us.

Neumann and Coryn make an incision around the anus and free the rectum from its attachments so that radium can be inserted into the growth externally and also into any perirectal infiltration of the neoplasm. Lockhart-Mummery uses a similar technique. He implants perirectally ten or twelve needles, each containing about 10 milligrams of radium bromide and leaves them in place for 24 to 36 hours. A colostomy is often included in the treatment.

Lockhart-Mummery feels that the technique of Neumann and Coryn has considerable merit. He adds that radium should *always* be inserted from the outside of the rectum. Gordon-Watson has been able to employ as much as 53.5 milligrams at one dose with this method, employing a maximum of 9,840 millicurie hours. We have had no experience with this method as yet. Sampson-Handley and others feel that there is reason to hope that ultimately operative procedures on carcinoma of the rectum will be abolished by improvements in radium treatment.

This method of radiation has definite possibilities. It seems radical compared to our present technique, but there is no reason why it could not be carried out. A patient who could not stand a colostomy and posterior resection might well be able to stand a colostomy

under local anæsthesia and then a freeing of the rectum under sacral anæsthesia so as to get at the growth without attempting a resection.

Binkley, of the General Memorial Hospital, New York, uses a radium pack employing two portals of entrance and giving about 10,000 millicurie hours at 10 centimeters distance, or he employs 1 cycle of high voltage X-ray treatment. He also uses gold seeds with 0.3 millimeter screening, giving from 10 to 65 millicuries (1300 to 8500 millicurie hours) at a dose. He plants the seeds via the rectal canal, the perineum, or posterior vaginal wall.

Binkley's figures are very encouraging. He reports 19 patients treated before 1925 alive for periods varying from 2½ to 7 years. In a verbal communication he states that most of these cases had pathological reports and that several are alive now. He further reports 100 cases treated between the years 1925 and 1927. Eighteen are free from disease. Many of these, he says, had pathological reports. If these are all cancer and if they live over 5 years without disease, he will have almost 20 per cent cures, which tallies well with the figures of Neumann and Coryn.

It is possible that in the future we may be able to render operable a seemingly hopeless case by the combined use of diathermy and radium used interstitially. Surgery with cancer of the rectum has very nearly reached its therapeutic limit but radium treatment of this disease is as yet very young. If a case is operable locally but the patient's general condition precludes a radical operation, an attempt can thus still be made at cure. We must bear in mind, however, that unless radium be given in adequate single dosage (i.e., 7,000 to 10,000 millicurie hours) it will not, save in rare instances, cure cancer of the rectum. Neumann and Coryn's technique should be carefully considered as their figures give more hope than any data heretofore published. We feel, however, that until their method has been carefully checked and its worth proved, radical operation is the method of choice as offering the patient the best chance of cure.

*X-ray treatment.* We are at present giving our patients the following X-ray treatment

TABLE XVI—AVERAGE LENGTH OF LIFE WITH DIFFERENT TYPES OF TREATMENT

Treatment	Cases	After onset of symptoms	After entrance to Huntington Hospital
1. No treatment	42	24	12
2. Colostomy alone	14	28	12
3. Radium alone	76	22	13
4. Colostomy and radium	46	32	17

—1100 R units—170 K V— $\frac{1}{2}$  mm copper filter Field 20 x 20 cm

We feel that the former X ray technique, in which only 120 kilovolts were used, is useless. We have not yet accumulated sufficient data regarding the present method to venture an opinion on it.

We do not advise pre operative treatment with radium for two reasons, first, because it delays adequate operative therapy and delay of course is never advisable in the presence of a neoplasm and second because such treatment makes the operation technically more difficult. Both of us have operated by the abdominoperitoneal route on patients so treated pre operatively. In each instance the area of radiation was solidly fixed to the surrounding tissues thus making it almost impossible to get a line of cleavage.

We are not impressed with the benefits to be gained by employing a colostomy before radiation as a routine measure. Each case must be considered as an individual problem. In some instances the secondary inflammatory reaction around the growth does subside after the fecal stream has been diverted but in others there is no such change and the patient may be made even worse symptomatically. It is possible however, that as we develop a more radical technique of radiation, colostomy will again have to be frequently employed.

It can be seen in Table XVIII that radium and X ray have not materially improved the patient's prognosis and that those receiving no treatment at all seemed to do as well if not better than those who have had X ray or radium or both. In our series, 42 cases received no treatment. The duration of life, from onset of symptoms, averaged 23.5 months. In this connection the natural duration of cancer is of interest. Lazarus Barlow, of the Middlesex Hospital, studied 345 instances of untreated cancer of the

rectum. He found that the average length of life with males was 20.4 months. With females the average was 25.9 months.

Wyard, in England, studied 450 cases. The average length of life was 29 months. Many of his and of Lazarus Barlow's patients had colostomies, but their experience with regard to colostomy coincides with ours, namely, that it alone does not prolong life sufficiently to warrant its routine use (Table XXI).

Colostomy as an adjunct to radiation apparently adds 4 months to the life of the average patient, but this is not always an unmixed blessing as many times the patient has thus not only the discomfort of a rectal growth but also the annoyance of caring for a colostomy.

Howard Kelly reports his experience with radium in the treatment of 133 cases. Seven of these, he says, lived over 3 years. One lived over 5 years. Twenty-seven per cent were not benefited at all.

#### SUMMARY AND CONCLUSIONS

1. This series embraces 303 cases clinically diagnosed cancer, between 1912 and 1928.
2. Adenomatous polyps constitute the most dangerous precancerous lesion.
3. The fifth decade of life shows greatest incidence of cases.
4. Family history of cancer is obtained in only 7 per cent of the cases.
5. Malignant adenoma and adenocarcinoma grade 1, the two lowest grades of malignancy, form 77 per cent of the 101 cases available for grading.
6. Biopsy for diagnosis, prior to instituting therapy, is always advisable and never harmful.
7. Change in bowel habits, bleeding, and rectal pain should always suggest the possibility of cancer even though hemorrhoids also are visible.
8. Digital rectal examination is sufficient to make a diagnosis in 95 per cent of cases.
9. Every cancer of the rectum is operable if discovered early enough, and the period during which it remains operable is longer than in most other cancers.
10. Obstruction necessitating emergency colostomy is rare in rectal cancer.

11 Colostomy, as an adjunct to radical operation, is always necessary

12 In the entire series only 21 cases who had positive pathological reports of cancer, are alive without symptoms, and all have had complete operations

13 A radical resection, by one of several methods, and including colostomy, offers the patient his best and, we believe, practically his only chance of cure

14 Radical operation definitely prolonged the life of the 42 who subsequently died of recurrence

15 Radium and X-ray, as at present used, must be considered purely as palliative agents in the treatment of cancer of the rectum

16 Our patients receiving no treatment lived about the same length of time, on the average, as did those radiated as described. Changes in technique of application may, in the future, improve this situation

17 Surgical diathermy is of use in reducing the bulk of an inoperable growth

We wish to express our thanks to Dr. Shields Warren, Dr. Lawrence Sophian, and Dr. William H. Lewis, to whom we are greatly indebted for their painstaking work in the pathological grading of the material from our cases

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## RESPIRATORY COMPLICATIONS AND THE SURGICAL PATIENT<sup>1</sup>

HAROLD L. FOSS, M.D., F.A.C.S. AND JOHN H. KUIP, M.D. DANVILLE, PENNSYLVANIA

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In 1896 Schultze reported from Whipple's study an incidence of 0.38 per cent of post-operative pneumonias. In 1913-1914 (Whipple 27 '88) the incidence was 2.2 per cent, while in 1915-1916 it was 2.6 per cent. Cutler and Hunt (3, 4) reported 1.86 per cent (1916), 3.52 per cent in 1920, and 3.92 per cent in 1922 for all pulmonary complications and, with the increase in morbidity, a corresponding decrease in mortality.

The earlier papers dealt with bronchio and lobar pneumonia only, but as time passed, the group enlarged to include other intrathoracic lesions especially infarction and massive collapse which have come, in late years, to be better understood. In Table I is shown the incidence of pulmonary complications recently reported from several well known clinics. In the chronological arrangement, taken from Cutler and Hunt, the increasing morbidity with the concomitant decrease in

mortality is well illustrated. Our own figures, as well as those of Decker, Ravdin and Kern, disagree somewhat with these. The trend of opinion favors the embolic origin of pulmonary complications, and the hypothesis that the aspiration of foreign and infected material is the chief cause of postoperative pneumonia is giving away largely to the former theory. Among those advocating the embolic theory may be mentioned Cutler and Hunt, Schlueter and Weidlen, and Fetterolf and Fox, while those favoring the aspiration theory include Hoelscher, Ochsner and Nesbit, Lemon, Smith, Moore, Crowe and Scarff, Allen, Myerson, and Iglauer. Undoubtedly, as has been repeatedly proved by animal experimentation (Lee, 12), aspiration of septic material may result in pneumonia and massive collapse, yet there is increasing evidence pointing to the frequency of postoperative embolism as the one condition preceding many cases of postoperative pulmonary disease.

The patients admitted to our service are less prone to respiratory conditions than patients seen in the larger cities. Most of them are sturdy farmers and railroad or mill workers who live relatively healthy lives. The conditions for which operations are performed compare with those in most general hospitals (Table II). In the 3 year period there were 3,433 operations performed on the general surgical service (that of H. L. I.).

Sixty patients (1.7 per cent) of this series developed pulmonary complications and of these 25 (0.72 per cent) died. Of every 58

<sup>1</sup>From The Surgical Service, Geisinger Memorial Hospital.

TABLE I—PULMONARY COMPLICATIONS

Clinic	Author and year	No of operations	Pulmonary morbidity		Pulmonary mortality		Mortality per cent of morbidity
			No	Per cent	No	Per cent	
Montreal General Hospital	Armstrong 1906	2 500	55	2.2	32	1.28	58.1
Von Eselsberg Vienna	Ranzi 1909	6 871	263	3.8			
Combined Statistics	von Lichtenberg 1908	23 673	440	1.9			
Mayo Clinic	Beckman 1910	3 657	41	1.12	9	.24	21.0
Mayo Clinic	Beckman 1912	5 815	92	1.57	6	.10	6.5
Mayo Clinic	Beckman 1913	6 825	87	1.27			
Mass General Hospital	Cutler and Morton 1917	3 490	65	1.86	33	.94	50.7
Combined Statistics	McClusson 1918	39 438		3.03		1.06	
Peter Bent Brigham Hospital	Cutler and Hunt 1920	1 562	55	3.52	11	.7	20.0
Pittsburgh	Decker 1921	5 976	69	1.2	29	.5	42.0
Peter Bent Brigham Hospital	Cutler and Hunt 1921	1 604	63	3.92	5	.31	7.93
Philadelphia	Raydin and Kern 1922-1925	5 966	69	1.15	28	.47	40.6
Gessinger Memorial Hospital	Foss and Kupp 1926-1929	3 433	60	1.70	25	.72	41.7

operations a pulmonary complication developed, and of every 137 operations, 0.72 per cent, the patient died as the result of the complication. The lesions studied have been classified as follows: lobar pneumonia, bronchopneumonia, bronchitis, embolism, infarction, massive collapse, and lung abscess. Following Cutler and Hunt, we list under *infarctions* those lesions often referred to as "postoperative pleurisy" and characterized by the appearance of sudden sharp pain in the chest with expectoration of mucus, occasionally blood stained, and, later, the presence of a friction rub, impaired breath sounds, impaired resonance, etc.,—the group to which Wharton and Pierson have applied the term "minor emboli." This group should be separated from the group in which massive pulmonary embolism develops and which usually terminates fatally. Although it is probable that these minor emboli are produced by the same mechanism that results in fatal pulmonary embolism, in the latter condition the obstructing mass is relatively much larger, producing complete occlusion of main pulmonary vessels. There is bound to be confusion in the differential diagnosis of these various lesions unless the chests are meticulously examined by one thoroughly versed in thoracic disease. While the exact diagnosis may be missed, the existence of some intrathoracic lesion is, however,

usually recognized. Recent studies tend to prove that the term "postoperative pneumonia" is far from an accurate one and that the majority of lesions developing within the lungs following surgical procedures are not true pneumonias.

#### LOBAR PNEUMONIA

There were in the entire group 3 cases of frank lobar pneumonia. Two recovered and one died. All the patients were under 40.

TABLE II—OPERATIONS ON GENERAL SURGICAL SERVICE

February 1, 1926—January 31, 1929		Cases
Appendix		315
Gall bladder		259
Small bowel		17
Large bowel		27
Rectum and anus		138
Stomach and duodenum		62
Abdomen, miscellaneous		109
Tongue		2
Esophagus		3
Herniorrhaphies		216
Breast		68
Genito urinary		256
Gynecological		612
Thyroid		355
Skull		3
Nerves or tendons		66
Arteries and veins		15
Extremities		393
Bones		317
Drainage of abscesses		168
Glands		32
Total		3,433



- 43 ROSSER C. The differential diagnosis of rectal cancer. *Texas State J. M.* 1928 xvi, 585-588.
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In 1898 Schultze reported from Whipple's study an incidence of 0.38 per cent of postoperative pneumonias. In 1913, 1914 (Whipple 27-28) the incidence was 2.2 per cent, while in 1915, 1916 it was 2.6 per cent. Cutler and Hunt (1-4) reported 1.86 per cent (1916), 3.52 per cent in 1920, and 3.92 per cent in 1922 for all pulmonary complications and, with the increase in morbidity a corresponding decrease in mortality.

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and one, three. Three of the patients developed a coincidental phlebitis. The duration of symptoms averaged 4 days, and the average day of onset was the seventeenth following operation.

It is interesting to note that postoperative bronchitis developed within the first week, while in cases of infarction not until the second or even third week. It is also worth noting that only with the cases of infarction was there a coincidental phlebitis.

#### EMBOLISM

There were 13 patients in this group, all succumbing to the condition. The criteria required in making the diagnosis of massive acute pulmonary embolism were sudden and severe pain in the chest associated with cough and expectoration of mucus, usually respiratory embarrassment with cyanosis, and death usually within a few minutes. All the patients in this group died within 2 hours following the onset of symptoms. Nine patients (69 per cent) were over 50 years of age. Six presented a history of chronic bronchitis preceding the operation. Eleven were definitely poor risks. The anæsthetic used was ether seven times, ethylene twice, and nitrous oxide four times. When the patients left the operating room, 6 were in good, 3 in fair, 1 in poor, and 1 in very poor condition. Four of the operations were for septic lesions and 9 for non-septic. The average duration of the anæsthesia was 43 minutes. Nine patients had abdominal incisions, 4 in the upper and 5 in the lower abdomen. One patient had a radical amputation of the breast, while with 3 the operation was performed on the extremities. In all cases the symptoms appeared suddenly and, usually, after a normal, uneventful convalescence.

Deaths occurred as follows on the first postoperative day 1, fourth day 1, fifth day 1, sixth day 1, seventh day 2, eleventh day 4, twenty-fourth day 1, thirty-third day 1, and forty-first day 1. The average duration between the onset of symptoms and death was 57 minutes. One patient experienced on the twenty-fourth day a sudden sharp pain in the chest associated with dyspnoea and tachycardia, and from this condition he recovered

only to succumb to a second attack on the forty-first day. Postmortem examinations were permitted in about one-third of these cases, in each instance a large thrombus being found in either the right or left main pulmonary artery.

#### MASSIVE COLLAPSE

There were two examples of this complication. With the histories again before us, we are bound to feel that where two cases were reported, several were overlooked or were incorrectly listed under pneumonia, bronchopneumonia, infarction, etc. With our far better understanding of this extraordinary condition, the surgical complication records of all hospitals are bound to show an increasing incidence. The generally accepted criteria were present in both of our cases. Respiratory movements were restricted on the affected side and the cardiac impulse displaced toward that side, the apex exhibiting a tendency to tilt upward and outward. The dome of the diaphragm was found to be abnormally high and immobile on the affected side. Both of our patients were males. One, who was 20 years of age, had a right inguinal herniorrhaphy and had suffered from chronic bronchitis for several years. The operation was performed under local anæsthesia. The day following the operation the temperature rose to 104 degrees, the pulse rate to 110, and the respiratory rate to 32. The patient developed a non-productive, irritating cough, and roentgenograms of the chest made a day later showed the characterized appearance of massive collapse. The temperature became normal after the sixth day, the patient fully recovering and being discharged on the fifteenth day.

#### ABSCESS

One patient developed a pulmonary abscess. The patient, 62 years of age, had received a gunshot wound resulting in a fracture of both bones of the leg. A month later an amputation had to be performed, and on the second day following the operation the patient developed bronchopneumonia which was followed later by the formation of an abscess. The patient ultimately recovered.

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and his associates in 100 bronchoscopies performed after tonsillectomy report aspiration of mucus or tissue particles as occurring in 40 per cent

These data, of course, tend to convince one that aspiration of mucus and foreign substances from the throat does not constitute the serious menace we have believed it to be, and that it is, probably, less important in the production of pulmonary complications than the deposition of emboli brought to the lungs by way of the blood stream from the operative field, especially following abdominal and other operations performed by the general surgeon. Exception might be made in the case of abscess. Cutler (5) shows in a recent survey that of 1,908 cases of lung abscess reported by various authors, 29 per cent followed general surgical operations, while 14 per cent were incident to tonsillectomy. Hedblom, in a report of 146 cases of postoperative lung abscess observed at the Mayo Clinic, found that 38 per cent followed laparotomy and 33 per cent tonsillectomy.

In November, 1928, we adopted spinal anesthesia to the exclusion of all other forms in operations performed below the diaphragm. With the first 400 operations there was an incidence of 1.7 per cent of pulmonary complications, equal to that in our previous series of patients operated under inhalation anesthetics (1.7 per cent).

The incidence of pulmonary complications, especially those of the pneumonic group, is greatest during the months of November, December, January, and February, the mortality being then correspondingly increased. The lobar and bronchopneumonias occurred almost invariably during these months. All but 4 of the 19 cases of bronchopneumonia and lobar pneumonia occurred between October and February.

There is a greater likelihood of pulmonary complications developing as age advances. The incidence was highest in the period from 51 to 60 years. Thirty-eight cases (61 per cent) occurred in patients over 40 years of age.

#### CONCLUSIONS

1 We believe that this study further strengthens the theory that embolism plays

the chief part in the production of most post-operative pulmonary complications.

2 Infarctions (minor emboli) are far more common than has been generally supposed.

3 Aspiration plays but a minor rôle in the production of pulmonary complications.

4 Pulmonary complications are infinitely less common following operations on the upper respiratory tract than following operations on the abdomen and pelvis.

5 Irritation by the anæsthetic or the aspiration of foreign substances during inhalation anæsthesia probably plays a part in the production of postoperative bronchitis and pneumonia. However, the fact that these complications, with great frequency, following spinal and even local infiltration anæsthesia suggests that other factors play an equally important part.

6 Pulmonary complications have their highest incidence in the winter months (December, January, and February) and are far more common in patients of advanced years.

7 In the light of our present knowledge, treatment of these conditions should consist of (1) hyperventilation during and after operation with carbon dioxide and oxygen, as advocated by Scott and Cutler, (2) change in the position of the patient every 6 hours, after operation (Sante), (3) curtailment of sedatives after operation, especially those which depress the cough reflex, and when collapse occurs, the bronchoscopic removal of the mucus or, whenever the other complications considered are present, the use of our newest and most valuable aid, the oxygen tent.

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TABLE III—ANÆSTHETICS AND POSTOPERATIVE MORTALITY

Anæsthetics	Number of administrations	Number of deaths	Mortality
Ether	1146	10	0.87
Ethylene	746	4	0.62
Nitrous oxide	626	6	0.95
Local	437	1	0.23
Nitrous oxide ether	384	2	0.52
Ethylene-ether	20	1	5.0
Other combinations	56	0	0.0

## COMMENT

In a series of 3,433 major surgical operations there were 60 instances of postoperative pulmonary complications. Of the 60, there were 15 cases of infarction, "minor emboli", 3 had more than one attack, 3 had an associated phlebitis. Sixteen patients developed bronchopneumonia. Three had attacks of sudden sharp pain and evidence of infarction prior to or during the course of, the pneumonia. Three had previous pulmonary disease. There were 3 cases of frank lobar pneumonia. There were 13 cases of pulmonary embolism, all terminating fatally. There were 11 cases of postoperative bronchitis. Eleven (18½ per cent) of the 60 patients had evidences of pre-existing pulmonary lesions.

The fact that most of the pneumonias are bronchial rather than lobar in type would indicate that they are caused by minute emboli. We believe that infected emboli and previous pulmonary disease play a more important part in the production of these complications than does aspiration of septic substances or irritation from the anæsthetic. It is probable however that irritation plays a part in the acute postoperative bronchitis cases, most of which develop during the first 2 days following operation.

It is interesting to note that in the majority of cases of infarction and embolism, the onset was at a much later date than was the case with the bronchitis or pneumonia. The infarction patients recovered in about one half the time required for those with bronchitis.

Arguments favoring the embolic origin of postoperative pulmonary lesions are, (1) late (i.e., after the sixth day) onset with sudden pain, few rales and, in a few cases, impaired breath sounds, with rapid recovery, (2) appearance of more than one attack, (3)

associated occurrence of phlebitis in some cases, (4) frequent occurrence after local anæsthesia.

In Table III is shown the mortality percentages with respect to the anæsthetics used, although most of the serious cases were operated under ether.

During the 3 years in which these operations were performed, in the nose and throat department there were 1,572 operations, tonsillectomies, adenoidectomies, submucous resections, etc., all under anæsthetics, mostly ether. There were no pulmonary complications. In the 10 year period, 1919-1928, among 4,182 consecutive operations there was not a pulmonary complication in this department. Of course, since the nose and throat patient averages only 2 or 3 days in the hospital, he may develop a complication after returning home although no such cases have been reported to us. This is an interesting comparison of the incidence of pulmonary complications of general surgery with that of otolaryngology, performed in the same institution under like conditions and with same operating room attaches, nurses, and anæsthetists.

TABLE IV—PULMONARY COMPLICATIONS FOLLOWING SPINAL ANÆSTHESIA

Operation	Age	Postoperative complications	Days after operation (Onset)	Result
Prostatectomy	53	Pleuritis	14	Recovered
Cholecystectomy	31	Cellulitis right lung	21	Recovered
Colostomy	75	Infarcti n and bronchopneumonia	22	Recovered
Appendectomy	55	Pleuritis	21	Recovered
Cholecystectomy	35	Necrosis collapse	12	Recovered
Cholecystectomy	54	Hypostatic pneumo nia	2	Died
Appendectomy	45	Pleuritis	14	Recovered

May, Thoburn, and Rosenberger have recently studied, radiographically, the aspiration of iodized oil into the bronchial tree of patients undergoing tonsillectomies. They conclude that some aspiration is unavoidable in all operations requiring an inhalation anæsthetic. In their series of patients they found that aspiration occurred in 48 per cent.

Similar conclusions were reached by Myerson (18) who, in a series of 200 cases, reports an aspiration percentage of 75 while the Dadds, in their series of 100 cases, report aspiration as occurring in 78 per cent. Iglaue

THE BLOOD SUPPLY OF THE HUMAN PARATHYROIDS<sup>1</sup>

GLORGE M. CURTIS, M.D., F.A.C.S. CHICAGO

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THE preservation of the function of the parathyroids during the course of operations upon the thyroid gland, calls for a knowledge not only of their location but also of their blood supply. The prevention of tetany necessitates first, that a sufficient number of the glandules be spared, also that those remaining shall have an intact blood supply.

The parathyroids lie, as a rule, in a zone along the posteromedial surfaces of the thyroid lobes. This "danger zone" is well recognized and, thanks also to the position of the adjacent recurrent nerves, a sufficient number of parathyroids is usually spared in subtotal resections of the lobes. However, variations from this usual position occur, and it is particularly these aberrant glandules which are likely to be removed. Wellbrock found that about 8 per cent of 1,056 thyroid glands removed at the Mayo Clinic revealed parathyroids. It thus becomes of increasing importance to maintain an intact blood supply to the glandules which remain.

Since the studies of Welsh and later of Halsted and Evans (13), which have been abundantly confirmed, it has been generally recognized that the parathyroids receive their blood supply principally from the inferior thyroid arteries. From this anatomical fact it would seem that these arteries should be carefully preserved during operations upon the thyroid gland. This view has actually been expressed, more recently by Dunhill. However, as a matter of clinical experience bilateral ligation of the inferior thyroid arteries, or for that matter of all four thyroid arteries (7, 8, 17), is but rarely followed by tetany (2).

The solution of this apparent inconsistency lies in the abundant collateral vessels between the inferior thyroid arteries and those of the larynx, pharynx, trachea, and oesophagus, as well as the anastomoses with the superior arteries. It is through these collaterals that blood is assumed to reach the parathyroids

even after ligation of all four of the main afferent trunks. In this study, we have experimentally examined the basis for this assumption by means of injections of the thyroid region before and after ligation of the thyroid arteries (5).

## APPARATUS AND METHODS

An especially designed pressure apparatus was employed in making the injections (5). The majority of the injections were made with a thin, carmine-gelatin mixture, which remains fluid at ordinary temperatures (15). The viscosity of this fluid is less than that of the thicker mass, consequently it passes into the capillaries more readily under ordinary temperatures and pressures. The injection pressure was ordinarily 150 millimeters of mercury.

In preparing a cadaver for injection, two effects were sought. *First*, to insure the injection of all those vessels giving collateral branches to the thyroid region. *Second*, to confine the injection mixture largely to this region. The first was accomplished by injection into the lower thoracic or upper abdominal aorta. The second was effected by bilateral ligation of those unnecessary arteries leading away from the cervical region, particularly the second division of the subclavian, the internal carotid, the terminal portion of the external carotid, the vertebral, and the internal mammary.

The larynx, pharynx, trachea, and oesophagus are firmly bound together in the neck by the deep cervical fascia. As a consequence the arteries to the upper respiratory and digestive tubes have common origins. The oesophageal and bronchial arteries bring blood to these regions from the upper thoracic aorta below. To conserve this supply the injections were made below the origin of these arteries.

## POSITION OF THE PARATHYROIDS

The position of the parathyroids is of the greatest importance in any consideration of

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vessels The larger collateral vessels below, from the inferior arteries, are the inferior laryngeal, the esophageal, and tracheal branches, and those to the isthmus Above, in addition, from the superior arteries, are the superior laryngeal, pharyngeal, and muscular branches and the cricothyroid arteries There is also a free anastomosis between the two thyroid arteries, particularly on the posterior surface of the gland, but to a certain extent also within its substance

#### EXPERIMENTAL DEMONSTRATION OF THE ABUNDANT COLLATERAL VESSELS

We have observed that the blood supply to the parathyroid glands arises, in nearly all instances, from the inferior thyroid arteries This is in accord with the observations of many others In the technique of thyroidectomy, particularly as developed by de Quervain (3), these two arteries are frequently ligated by a preliminary well planned procedure (4) This procedure is very rarely followed by even a mild, transient tetany, hence it appears clinically that the glands have an adequate collateral blood supply Following the principles as developed by Pectenoff, Enderlen and Hotz, we have studied this question experimentally by first ligating both inferior thyroid arteries in the customary manner of the clinic (4), making the injection as described, and finally examining the parathyroids microscopically for the presence of the injection mixture Two bodies were thus successfully injected

After preliminary ligation of the unnecessary arteries, the inferior thyroid arteries were exposed extracapsularly, between the common carotid and the thyroid gland (4) They were then ligated at the commencement of the horizontal portion, in order to insure ligation of the main trunk Injections were made and the parathyroids located, removed, and sectioned Not all the injections attempted were successful However, in two bodies it was possible to demonstrate the presence of the injection mixture in the parathyroid glands, when these were frozen, cut, and examined In one body the ligated inferior arteries, lying on the posterior surface of the thyroid, were well injected up to the point of ligation

We have recorded the number of arteries ligated, preliminary to thyroidectomy, in 270 consecutive operations performed in the Berne Clinic between October 1, 1925, and December 31, 1926 These cases were carefully followed The data have been presented (5) In 40 per cent three arteries were ligated The ligation of three arteries is usually of both inferiors and the anterior divisions of both superiors All four arteries were ligated in less than 1 per cent of the cases, and the average number of arteries ligated per operation was but 2.28

Since in this series the preliminary ligation of three arteries was the most frequent procedure, it was attempted in 5 bodies preliminary to the injections Both inferior thyroid arteries were ligated as usual (4) The anterior branches of both superior arteries were ligated by forcing a threaded aneurism needle through the anterior half of the superior pole of the thyroid gland and ligating this with its attached vessels An attempt was made to spare the posterior division, passing along the posterior or posteromedial surface of the lobe After the injections carmine gelatin was evident microscopically in the parathyroid sinusoids in 3 of the 5 bodies In 2 bodies the injection was unsatisfactory owing to technical difficulties In the 3 bodies it was also possible to demonstrate the injection mixture within the posterior portions of both thyroid lobes in the parathyroid region

In 2 bodies three of the four arterial trunks were first ligated, and the collateral circulation to the parathyroids again tested by making the usual injection The two inferior arteries were ligated as usual and the left superior artery was tied at the superior pole Considerable injection mixture was found in the right upper lobe, and below, since the right superior artery was left patent However, the mixture was also demonstrable in the left lobe In both bodies frozen sections revealed the presence of the carmine stained mass within the parathyroid sinusoids In one body three of the glandules contained visible amounts of carmine gelatin

As a final test all four thyroid arteries were ligated in 3 cadavers preparatory to making the usual injection The two inferior arteries



their collateral blood supply. Consequently, they were identified and examined in 12 cadavers, by dissection. The small brownish bodies of varying shape and size were first located, then removed and proved to be parathyroids by making frozen sections of the glandules. All four parathyroids were found in 11 cadavers. In 1, the left superior parathyroid could not be located. The glandules vary in size, shape, and even in color. They may conceivably be confused with small lobules of fat, with accessory nodules of thyroid tissue, or even with lymph glands (11). Such uncertainty was quickly dispelled in this study, however, by an examination of frozen sections. One inferior parathyroid was found embedded in the substance of the thyroid gland, immediately beneath the thyroid capsule.

Accessory parathyroids have recently received renewed attention, particularly in relation to resected thyroid lobes (16, 18, 19). At the time this study was made no particular search was made for these on the frank anterior surfaces of the thyroid lobes. However, one aberrant gland was found on the antero-lateral surface of the left lobe.

The majority of the parathyroids lie between the thyroid fascia and the thyroid capsule, within the thyroid space (3), in a zone between the thyroid, trachea, and œsophagus. In this situation they are in intimate relationship with the anastomotic vessels between the thyroid arteries and those of the respiratory and digestive tubes. Collateral vessels between these structures and their enveloping fasciæ pass through this zone, and the parathyroid arteries may even arise from them (8, 9, 10, 13, 17). A knowledge of this position and relationship, recognized by Halsted (12) on the basis of MacCallum's dissections, and designated by de Quervain the "*danger zone*," is of manifest importance in preserving the parathyroids as well as their collateral blood supply during subtotal thyroidectomy.

#### NORMAL BLOOD SUPPLY OF THE PARATHYROIDS

In 8 bodies the injections were made, previous to a necropsy, without any preliminary ligation of the thyroid arteries. The parathy-

roid area was then dissected and its blood supply examined. Our findings regarding the actual blood vessels to the parathyroids are in most respects similar to those of Halsted and Evans (13). These have been confirmed by many (1, 14). The glandules receive a single artery of variable length which enters at the hilum, and courses within the center of the glandule (20). There are no visible anastomoses between the gland sheath and the surrounding connective tissue. The inferior parathyroid arteries arise from the inferior thyroid artery. They may arise from the main subdivisions, or from any of the terminal branches. In 2 cases they arose from the inferior laryngeal artery, on its way to the larynx. In 3 cases they arose from branches which farther in their course penetrated the œsophageal wall. A similar origin from these anastomotic vessels has been frequently observed, and figured. They also arise from a posterior anastomotic "channel" between the superior and inferior arteries. In 1 cadaver the left inferior thyroid artery was absent, and the left inferior parathyroid artery arose from a continuation of the posterior branch of the superior thyroid artery. The arteries may also arise from branches destined to form an anastomosis with vessels of the opposite side, particularly behind the isthmus.

The superior parathyroid arteries arise commonly from terminal branches of the inferior thyroid arteries. In 2 cases these terminal branches were farther traced into the wall of the œsophagus. They may also arise from the anastomotic "channel" (13) connecting the two thyroid arteries. In unusual cases they arise from branches of the posterior or medial divisions of the superior thyroid arteries. Gansberg (10) has figured such an instance. The parathyroid arteries are readily recognized. They may be as long as 2 centimeters.

The important collateral blood supply connecting the branches from which the parathyroid arteries arise with the arteries of the larynx, pharynx, trachea, œsophagus, and the adjacent cervical fasciæ, is surprisingly abundant. Connecting vessels may be readily traced to these structures. Terminal branches of both thyroid arteries anastomose across the isthmus, and behind the isthmus with tracheal

even of all four thyroid arteries, substantiates this conclusion and places it on a firm experimental basis

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were ligated as usual. The two superior arteries were ligated just above the gland substance. The injections were made with a hot, thin mixture and were considerably prolonged at sufficient pressure to insure the possibility of filling all collaterals. The cervical viscera were then removed *in toto*, and the parathyroids located, removed, and examined microscopically. Thyroid tissue was also removed from nearby each pole, in the posterior subcapsular region, and examined microscopically.

It was possible to demonstrate microscopically the carmine gelatin mixture in the majority of the parathyroids, and also in the excised pieces of thyroid tissue. In one body carmine gelatin was definitely visible in the sinusoids in two of the parathyroids. In the third the right inferior parathyroid, there was but a moderate amount of the colored mixture. In the fourth, the left inferior glandule there was so slight an amount evident that its presence might be questioned. The four subcapsular pieces of thyroid tissue revealed a moderate amount of the carmine-gelatin mixture in all save one piece, that from the right lower lobe. No thyroidea ima artery was present.

The collateral supply in these cases is clearly from the arteries of the digestive and respiratory tubes. Above, the larynx is supplied by the hyoid branches of the lingual arteries, the superior laryngeal branches from the trunks of the superior thyroid arteries, and muscular branches including the cricothyroid arteries. The latter may be cut off by the ligature at the superior pole. From below come the bronchial arteries anastomosing with those of the trachea. The pharynx, above, receives branches from the first portion of the superior thyroids and the ascending pharyngeal arteries. From below come the oesophageal arteries. About the viscera are small vessels in the deep cervical fasciæ. Blood can thus pass particularly from the trachea and oesophagus through abundant anastomoses back into the thyroid arteries.

#### SUMMARY

The blood supply to the human parathyroids, particularly the collateral blood supply,

was studied in a series of 25 cadavers immediately preceding necropsy. An especially devised injection apparatus was employed. A carmine gelatin mass was injected into the lower thoracic aorta, below the origin of the bronchial and oesophageal arteries, at a pressure of 150 millimeters of mercury. By preliminary ligature of unnecessary arteries leading away from the neck, the injection was localized largely to the thyroid area. Abundant anastomoses were demonstrated between the thyroid arteries, especially the inferior, and the arteries of the larynx, pharynx, trachea, oesophagus, and their surrounding fasciæ. The thyroid arteries also anastomose with one another and across the median line, particularly in the region of the isthmus. The parathyroids receive their single artery as a rule from the inferior arteries.

After preliminary ligation of both inferior thyroid arteries, the presence of carmine gelatin was demonstrated in the parathyroids after injections, by means of frozen sections. After ligature of both inferior thyroid arteries, together with the anterior branches of both superior thyroid arteries, the injection mass was demonstrated in the parathyroids by the same method. In 3 bodies all four arterial trunks were ligated preliminary to the injections. The mixture was subsequently demonstrated in the vascular spaces of the parathyroids. The fascial connections posteriorly between the thyroid and the trachea and oesophagus, particularly in the region of the isthmus and the medial borders of both lobes are important in maintaining this collateral supply.

In the Surgical Clinic in Rome it is a frequent procedure to ligate both inferior thyroid arteries as a hæmostatic measure preliminary to a thyroidectomy. In many instances the anterior branches of the superior arteries are ligated at the same time. In less than 1 per cent of the cases all four of the arterial trunks are ligated. Since tetany does not follow these procedures it is apparent, from extensive clinical evidence, that the collateral blood supply to the parathyroids is ample. The demonstration of injection mixture in the parathyroid glands following the preliminary ligature of both inferior thyroid arteries, and

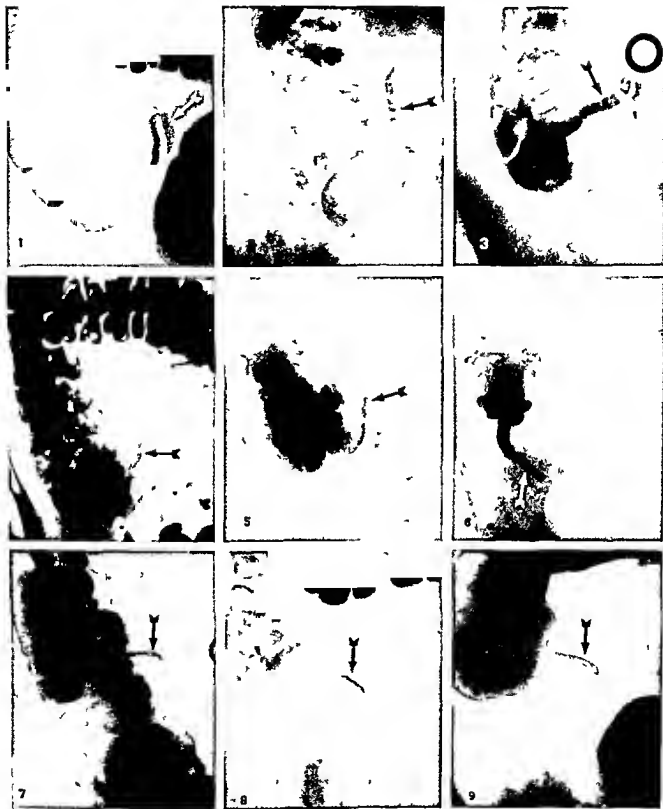


Fig. 1 The rigid appendix contrasted with the normal appendix. 1 The normal appendix as homogeneously filled by the barium enema. The lumen is fairly uniform. It is free floating among the intestines, readily moved by palpation, and without tenderness. 2, 3, 4, 5, and 6 The appendix is persistently rigid indicating a gross infiltration of the walls and is accompanied by a motor impairment (stasis) in spite of an open lumen. Cecal stasis, as shown, usually accompanies this. 7, 8 and 9, The appendix, observed in the same case on three different occasions, maintains its relative and fixed position.

ROENTGENOLOGY OF THE APPENDIX<sup>1</sup>

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THE contribution of roentgenology to the diagnosis of chronic appendicitis is often disparaged [Bettman, Carnett and Boles, and Deaver (6)]. This occurs in spite of the obvious fact that correction of the adverse percentage of results for the operation for chronic appendicitis demands more certain diagnosis. The help given by roentgenology must generally be poorly understood by clinicians to be thus rejected when more help for accurate diagnosis is needed. It is unfortunate that one author should say, 'the main cause of needless appendectomies is the *furor op randi* of ambitious surgeons. Their chief aid and abettor is the roentgenologist. In no other department of roentgenology is there so much confusion and misunderstanding.' Rohdenberg calls attention to the fact that chronic or productive changes do not markedly increase the liability of the appendix to fall a prey to severe acute inflammation. It cannot be claimed that the roentgenogram with the related roentgenological findings will make the diagnosis but in most cases roentgenology will contribute facts of great value to the final diagnosis. To this end the roentgenological data must always be considered together with the clinical findings. The diagnosis of chronic appendicitis is incomplete, the one without the other. Without debating the term, 'chronic appendicitis,' it is used in this article in the broadest sense as including all cases which are not so acute as to preclude roentgenology.

The failures of operation for chronic appendicitis have not all been complete failures. Associated disease undiagnosed and untreated, has often caused an incomplete clinical result. Roentgenology will also serve in establishing concurrent alimentary disease. Therefore, roentgenology of the appendix should not be practiced separately, but as part of a complete and general roentgenological gastrointestinal examination. This will include cholecystography. This increases in estimably the value of the whole examination by its demonstration of the functional status

of the gall bladder, which may thereby be established as part of, or eliminated from, the clinical problem. Elsewhere (10), it is shown that ulcer and cholecystitis are with great frequency associated with and sequel to chronic appendiceal disease, especially where the appendectomy has been delayed beyond the usual early age period (15 to 25) of unassociated appendicitis. Solieri calls the frequent association of appendicitis, peptic ulcer, and cholecystitis, "the pathological harmony of the right abdomen" and is convinced they are connected by a pathogenetic bond. Chronic appendicitis frequently creates a clinical syndrome simulating duodenal ulcer, which can be differentiated only by gastrointestinal roentgenology.

There are relatively few occasions in the broad field of diagnostic roentgenology when the roentgenological evidence can alone complete the diagnosis or give the indications for treatment. This evidence, as a general rule, should not be given an independent responsibility for a final diagnosis. The abuse of this principle rests more often with the physician than with the roentgenologist.

In 1925, the roentgenological signs of a pathologically altered appendix were clearly presented by White. Since then certain very helpful signs have been developed and experience has further proved the value of the signs and shown the association of appendiceal disease with the other abdominal conditions. The significance of visualization or of non-visualization has been debated far beyond the value of the point involved and in the face of an obvious need for accessory data to give weight to either status. The statistics of visualization by different observers has ranged from 10 per cent to 100 per cent. The failure of the appendix to be visualized upon repeated examination can be only suggestive of disease. The normal appendix is visualized only by the opportune coincidence of its filled condition to the roentgenographic or fluoroscopic observation. Non visualization never necessarily means an occluded and non fillable

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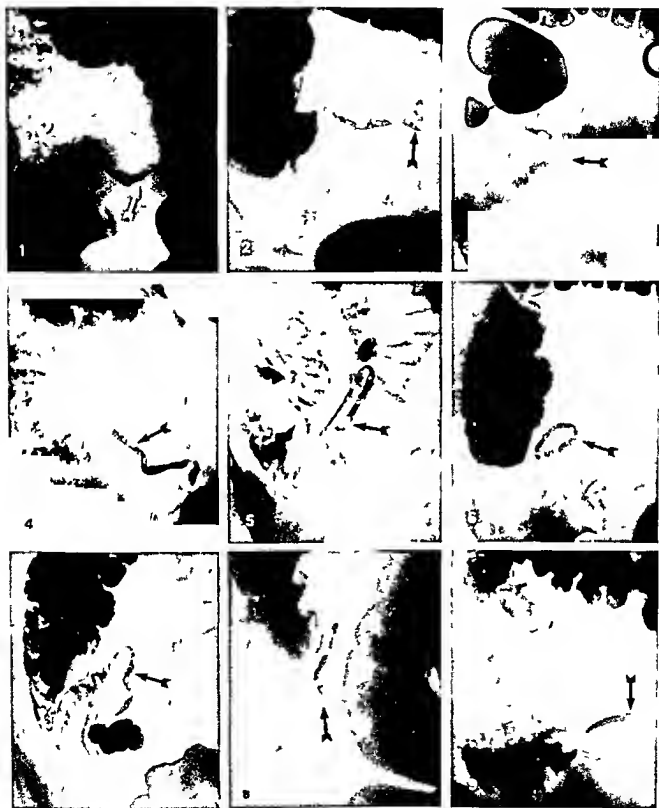


Fig 3 Retained concretions These are shown by defects ("holes" or "vacuoles") in the barium shadow of the appendix lumen

have emptied itself of barium prior to even repeated roentgenograms. Only when well supported by the secondary signs described later does non-visualization upon repeated

observation gain the significance of pathological occlusion. And visualization gives evidence of pathology only by revealing an altered structure. The accompanying table

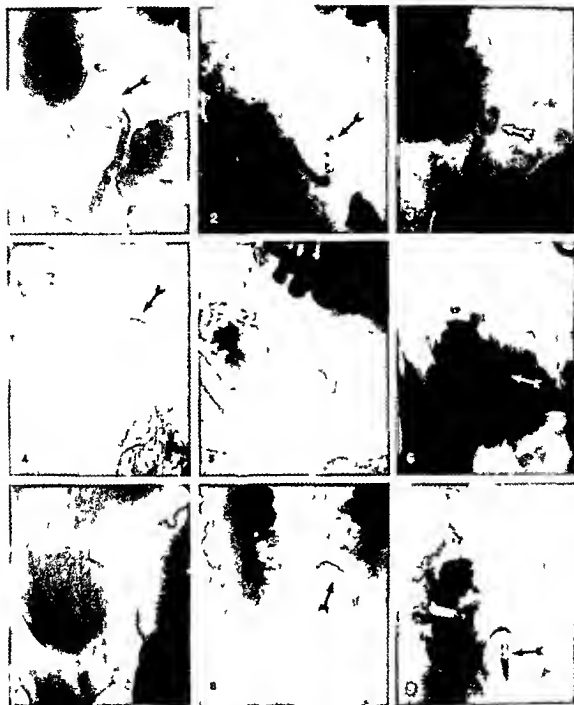


Fig 2 Dilatation of the appendix 1 2 and 3 Uniform dilatation of the lumen from increased intracecal tension 4 to 9 Dilatation tending to cystic distention of the lumen distally because of proximal partial occlusion

appendix. The normal appendix can and does empty itself very shortly after the cecum has emptied. The force of the peristaltic waves in the appendix has been demonstrated in the

experimental animal (7), and the peristalsis observed in the appendix of man, leads to the conclusion that the normal human appendix has a vigorous motility. It may conceivably

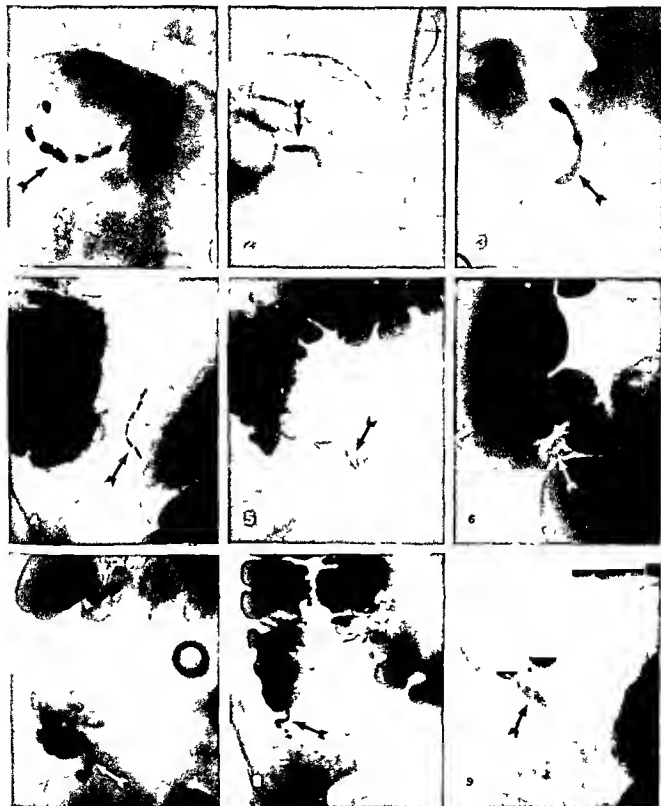


Fig 5 Impaired motility of the appendix (appendostasis) 1, After 4 weeks barium remains in the appendix 2, After 4 days barium is found in the appendix on the occasion of a urological examination 3, Peristalsis is unable to empty the appendix 4, Beaded barium at the 24 hour observation 5, Barium residue outlining the lumen which retains non bariumized content 6, Barium remaining in the appendix from the fed test at the time of a barium enema 7, The appendix filled and deformed with associated stasis in the cecum, the ascending colon has emptied This suggests an associated typhlitis 8, The filled appendix fixed in a coiled shape below the cecum, which shape and relative position is retained in the barium enema observation 9, The same appendix filled by the barium enema and showing by the darker portions of the shadow the barium which remained from the fed test



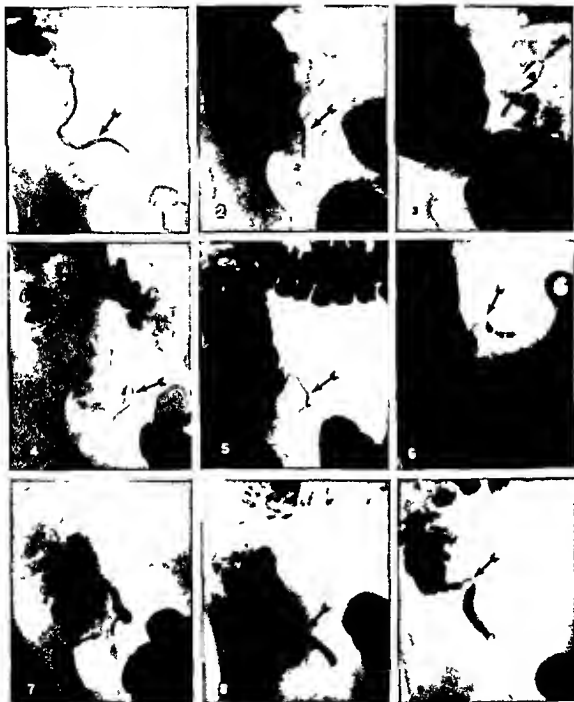


Fig 4 Obliterative narrowing of the lumen by changes in the walls of the appendix 1 and 3 Appendices with the lumen fairly uniformly narrowed 4 The appendix is almost obliterated with only a thread line lumen persisting 5 The appendix is almost obliterated excepting for a bulbous tip which retains a concretion 6 Localized obliteration change in the wall producing a constriction of proximal portion and marked stasis distally 7 Narrowing of the lumen distally with slightly bulbous tip and retained fecaliths The proximal half is slightly dilated The cecum shows a motor delay 8 Localized constriction occurring in two places The cecum shows a motor delay 9 Proximal constriction with distal dilation and retained fecaliths The cecum shows a motor delay

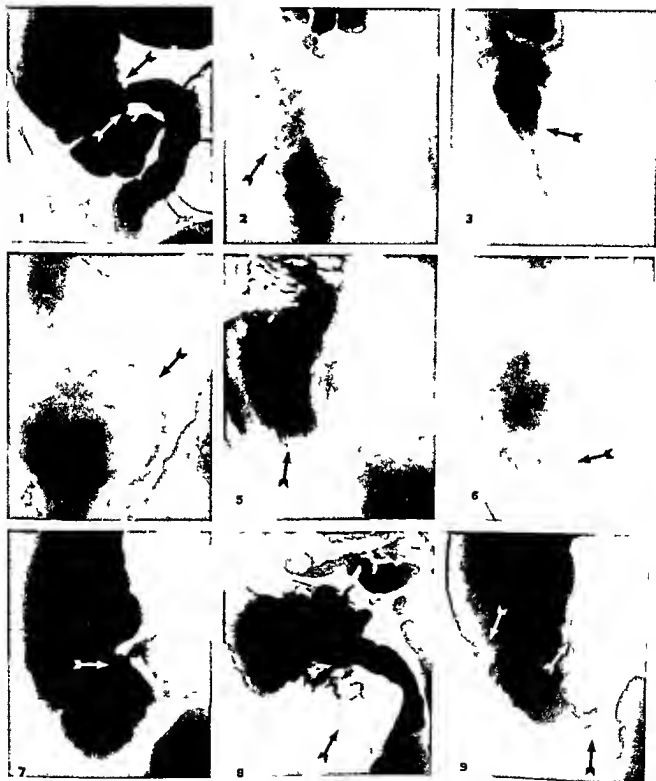


Fig 7 Conditions requiring differential diagnosis from appendicitis 1, Secondary ulcerative tuberculosis of the ileocecal valve and adjacent mucosa 2, Simple typhlitis causing a localized segmental hypermotility Tenderness was diffuse over the cecum The appendix was not visualized 3 Simple typhlitis which has progressed to cause impaired motility of the terminal cecum and appendix which shares in the irritation The appendix is of the embryonic type 4, Typhlitis and ileitis resulting in a palpable tumefaction Resection of the cecum and terminal ileum was done with no findings indicating a specific etiology 5 Ulcerative ileocecal tuberculosis secondary to pulmonary tuberculosis more extensive and advanced than that shown in 1 6, Deformity of the cecum resulting from palpable cancer 7, The ileocecal valve is incompetent in presence of good caecal tonus indicating other than a functional cause for the failure of the valve 8, Deformity of the cecum and displacement of the terminal ileum by a peri appendiceal abscess which had been present 2 months 9 Two diverticula of the cecum, introducing the necessity for differential consideration between a diverticulitis and an active appendicitis

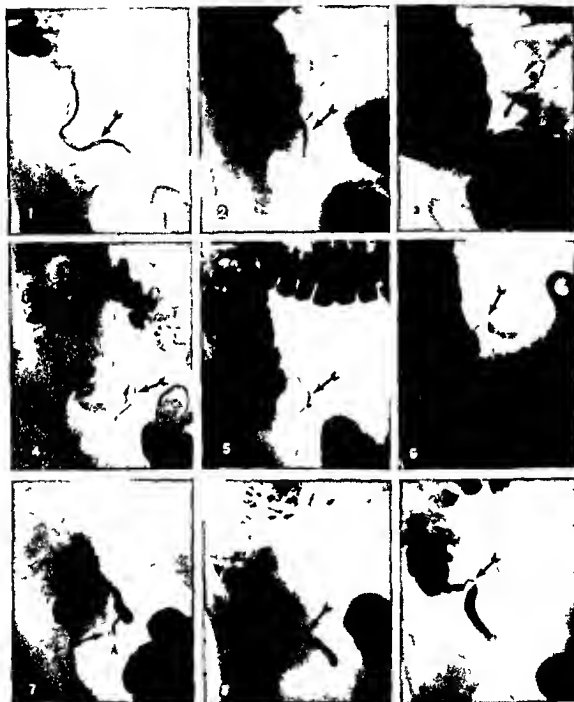


Fig 4 Obliterative narrowing of the lumen by changes in the walls of the appendix 1 2 and 3 Appendices with the lumen fairly uniformly narrowed 4 The appendix is almost obliterated with only a thread line lumen persisting 5 The appendix is almost obliterated excepting for a bulbous tip which retains a concretion 6 Localized obliterative change in the wall producing a constriction of proximal portion and marked stasis distally 7 Narrowing of the lumen distally with slightly bulbous tip and retained fecoliths The proximal half is slightly dilated The cecum shows a motor delay 8 Localized constriction occurring in two places The cecum shows a motor delay 9 Proximal constriction with distal dilation and retained fecoliths The cecum shows a motor delay

lumen, stiffening of the wall, and bulbous distention, which may become cystic dilatation, are pathognomonic of anatomical change. That the demonstration of these anatomical changes in the appendix in the adult is evidence only of involution is not tenable. But these changes alone are not conclusive of clinical appendicitis. They may be residual only.

Abnormal position of the appendix may be casual or fixed and when fixed may be of congenital or acquired origin. The congenitally abnormal fixed position is usually retrocaecal. It is a basis for anatomical pathological change. The acquired fixed position is the result of inflammatory penetration of the wall of the appendix producing adhesion to the adjacent structures which may cause absolute fixation to the parietes, or relative fixation to the cæcum and ilium with which it then shares in mobility and to which it maintains its relative position. The retrocaecal position of the appendix is important because it varies the clinical picture and complicates surgical interference. It is usually congenital and occurs by hyperrotation and descent of the cæcum. Its fixation is more often acquired.

The impairment of the motility of the appendix is shown by the retention of barium after the cæcum has emptied. This may be protracted. It is more significant when the motility of the appendix is delayed at 24 hours with the right colon emptied than if delay at 72 hours occurs with caecal and right colonic stasis. Instances are seen in which barium has remained in the appendix for weeks. Retained non-opaque faecal masses (stercoliths, faecoliths, or concretions) are revealed by infiltration of barium about them within the lumen. They appear as vacuoles or holes in the barium. It can be conceived that such retained material may occlude the appendix to any filling with barium and that this may account for non-visualization. Concretions are an expression of a previous or co-existent inflammatory process and are not themselves the exciting cause of the initial inflammation. The facility with which the unchanged appendix energetically empties itself in experimental observations lends support to the premise that retained concretions occur and persist because

of chronic motor impairment. That concretions may subsequently be a factor in the origin of acute disease is shown by surgical experiences. Archibald found 22 in 41 cases of perforation and 3 in 38 non-perforation cases. Bowen noted concretions in 80 per cent of abscessing or gangrenous appendices and in only 9 per cent of catarrhal appendices. Deaver (5) found a faecolith in 22.3 per cent of 120 acute cases.

The deformity of the appendix, often described as a "link," is most difficult to determine. Projection of curves upon the plane picture of the film will simulate them. They cannot be asserted in any case unless other changes are concomitant. Actual fixation of the deformity should be determined together with the resultant changes in the distal lumen, motor impairment, and dilatation.

The topographical position of the appendix has wide variations, although usually it extends to the left and below the ileocaecal junction near the classical McBurney's point. It may, however, radiate in any direction from this point. Roentgenology has shown the inconstancy of McBurney's point for the appendix and has disproved the validity of that point for its certain palpation. The rotation of the cæcum and its migration vary greatly. These variations are congenital as shown by studies upon the new born (9). The topographical level or the height of the viscera in the abdomen varies also according to bodily habitus. The normal position of the cæcum is given a wide vertical range by these several factors. In addition, it may be in such wholly anomalous positions as the infrahepatic, midline, or the left pelvic. Physical diagnosis has not yet given proper attention to these variable positions of the appendix which force upon many of the maneuvers of palpation a reservation as to their reliability. In the low pelvic cæcum of the congenital ptosis of the asthenic bodily habitus, the relative position of the appendix to the cæcum will be as usual, and, when filled, it may be seen to the left of the cæcum unless obscured by the adjacent rectum. The appendix will have a semi-retrocaecal position to that cæcum which has taken a pelvic position because the right colonic segment has an increased length.

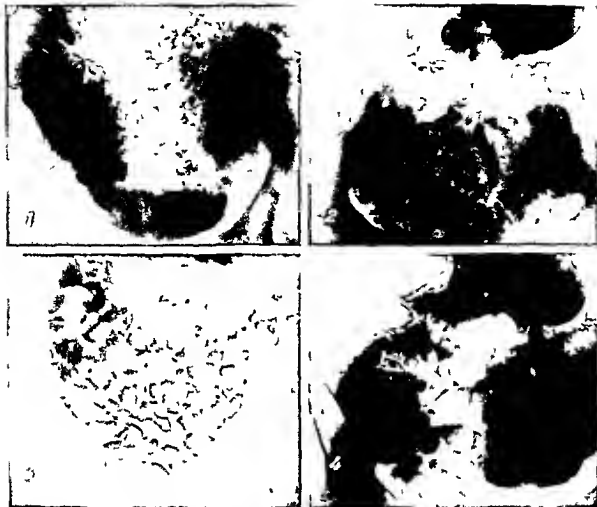


Fig. 8 The irritation pattern of the small intestine in the vertical film taken at the 6-hour period. 1 The usual or normal picture of barium in the small intestine at 6 hours after ingestion, appearing as a homogenous density in the ileum and as feathered remnants in the jejunum. 2 The barium appears in small discrete patches throughout the small intestine as the result of intermittent gastric clearance due to partial pyloric stenosis from ulcer. 3 The barium appears in gross discrete patches throughout the small intestine as the result of the effect of a peritoneal change from pelvic inflammatory disease. Such a picture varying in definiteness may result from past or present peritoneal irritation ranging in degree from congestion to peritonitis. 4 The irritation pattern of discrete patches of barium is localized in this picture to the terminal ileum in the region of the appendix. This gives presumption to its origin from appendiceal inflammation.

shows the findings with the appendix in a series of 4,049 complete gastro intestinal roentgenological examinations. Significant appendiceal findings occurred almost five times as often with visualization as without visualization, and 50 per cent of the visualized appendices had associated signs of pathology, while, with only 5.3 per cent of instances of non-visualization were there associated findings of conclusive significance. Visualization of the appendix has often been demonstrated

a few hours after a barium enema when it was not visualized in the fud test. The more uniform distribution of the intracecal tension by the fluidity of the enema allows for easier percolation into the appendix. The post enema appendix film is routinely included in the examination.

Structural changes of the appendix will be revealed by its barium filled lumen. Pathological form of the lumen is a dependable finding. Strictures, filiform reduction of the

SUMMARY OF APPENDIX X-RAY DIAGNOSIS IN  
FOUR-THOUSAND AND FORTY-NINE CASES  
WITH THIRTY-FOUR AND TWO-TENTHS PER  
CENT VISUALIZATION

	Visualized	Non visualized	Total
Appendicitis*	7	20	27
Pathological appendix			
Quiescent†	272	0	272
Irritable‡	227	0	227
Irritable appendix§	207	224	321
Indeterminate findings¶	663	0	663
Totals	1137	224	1361

Sub-acute inflammatory disease or localized peri-appendiceal abscesses with a pericæcal mass and irritation forms of the intestinal loops  
† Filtered structure retained concretions and postinflammatory fixation without palpable tenderness

‡ Structural alterations with palpable tenderness localized to the appendix and following its displacement

§ Tenderness localized to the appendix area with marked secondary findings without definite intrinsic change when visualized

¶ Visualized without significant structural alterations tenderness or secondary signs

highest value. They are observed in the vertical abdominal film made at the completion of gastric emptying or at the arbitrary six-hour observation. There are few other frequent causes for these atypical irritation forms than appendicitis and these other conditions have been found to occur mostly in the female pelvis.

This pattern is reliable, when present, as a record of previous acute or subacute appendicitis, although this may not appear in the clinical history. Even in the female, these irritation forms may be so localized to the appendiceal area as unlikely to be the result of pelvic disease. Handling of the intestines at laparotomy will result in this roentgenological picture subsequently, although usually in its lesser degrees of distinctiveness.

The incompetent ileocæcal sphincter has not been given any relation to the disease of the appendix. However, when the cæcum shows good muscular tonus with active haustrations, and with the marked haustral incisura opposing the valve, any accompanying incompetence is due to pathological interference and not to relaxation. Schultze shows that the valve acts mechanically and not as a muscular sphincter and that closure requires tension of the tentorium cæcale in applying the upper lip to the lower. He finds in one-third of cadavers a pathological cause for insufficiency. The pathological causes, other

than senile atrophy, may be peri-appendiceal disease or pathological processes of the valve itself. Incompetency of the valve in the presence of good cæcal tonus is evidence of regional disease, which usually is appendicitis, postoperative conditions, or typhlitis. Incompetency of the ileocæcal valve when the cæcum shows good tonus is a supplementary sign of appendiceal disease.

Appendiceal abscess may become localized and clinically subacute. There will then often be characteristic alteration of the harum passage through the adjacent small intestine. The roentgenograms will be helpful in diagnosis. The course of the terminal ilium and the contour of the lower and left border of the cæcum may describe the globular shape of the abscess, which displaces these and other intestinal loops. The irritation forms of the small intestines which are described above will give evidence of the associated regional peritonitis. A palpable mass, fluoroscopically oriented to the appendiceal area and determined to be displacing the terminal ilium and deforming the cæcum, completes the roentgenological evidence.

The operative confirmation of these roentgenological findings of the appendix in 358 instances has justified their use in diagnosis. Only roentgenology will develop the intrinsic and direct signs of appendiceal pathological change. Roentgenograms will in a large percentage of instances show the appendiceal lumen. Often this will indicate definite anatomical changes. Chiefly with, but also without visualization, there may be adduced from the films and by fluoroscopic palpation associated evidence, which will have additional significance. Such objective evidence of anatomical change is not alone proof of an active relation to any clinical syndrome. It must find definite correlation to the clinical findings. The roentgenological facts about the appendix are objective and valid facts which cannot rightly be ignored in diagnostic attention to the appendix. Their consideration in connection with other findings in alimentary and abdominal syndromes will increase the accuracy of diagnosis and can bring about improvement in the adverse statistical results of surgery of the appendix.

This topography results from congenital hyperrotation of the colon. The appendix in this position may often only be seen and roentgenographed with the patient turned in a manner to present a left anterior view. Hyperrotation of the colon may even turn the appendix to the right of the cecum.

The foregoing presents the variations of the appendix as shown by roentgenograms. These details are much better seen in good films than by fluoroscopy. It is not therefore debatable that fluoroscopy alone is adequate for diagnostic observation of the appendix. Fluoroscopy supplements the roentgenographic observations and is indispensable. It directly attaches the clinical attributes to the physical pathology. Fixation of the appendix and of the cecum may better be determined and the non-roentgenological sign of tenderness may best be investigated. Many of the maneuvers of palpation in physical diagnosis are predicated upon McBurney's point for the topographical position of the appendix, yet it departs from this point in 13.5 per cent of persons even in the recumbent position (9). Tenderness is not present with palpation of the normal appendix. Its occurrence indicates an abnormal sensitiveness of the organ. To be characteristic this tenderness is localized or centered to the origin of the appendix from the cecum, and this point of greatest tenderness follows displacements of the cecum. As a corollary, it can be shown to be absent from where the cecum and appendix are displaced. A similar tenderness to pressure should not occur in the left abdomen unless other coincident disease is present, usually diverticulitis, or a simple spastic and palpable sigmoid. Palpable tenderness of the appendix is often referred to the umbilicus or to the epigastrium and is frequently subjectively noted by the patient wholly in those ectopic positions. The tenderness of the lumbar spine resulting from spinal malstatics, of which lordosis is common, is the most frequent of lower mid-abdominal palpable tenderness and must be differentiated. Tenderness of the spine to palpation may even be unilateral and along the right margin of the vertebra. Pain localized to the sacro-iliac articulation may be more confusing, although it occurs less frequently.

It is not the place here to discuss the significance of tenderness found elsewhere than at the appendix and cecum, but such other tenderness is of value in solving the problem of a syndrome which has clinically suggested appendicitis. The evaluation of hypersensitiveness of the right abdominal wall is greatly aided by fluoroscopic palpation of the bariumized cecum and appendix. Tenderness due to and localized to other abdominal disease can be demonstrated as not localizing to the appendix. The filled cecum, especially when retaining the inspissated material of stasis can be very tender, and this tenderness perforce follows displacements of the cecum. Typhlitis, simple and catarrhal in type, often accompanies a pathological appendix and may be more significant to the clinical syndrome than the altered appendix. Also the failure to correct a residual typhlitis will spoil the clinical result of many valid appendectomies. By typhlitis is meant a chronic afebrile, more or less painful condition of the ileocecal region. It may be part of a more extensive colitis. It may occur without a demonstrably altered appendix and may itself wholly account for the clinical syndrome. The feathery contour of the enema (barium) filled cecum evidences the mucus which characterizes the condition. When advanced there will be an accelerated motility to the cecum due to its more irritable condition. The motility of any segment of the alimentary tract can be judged only with knowledge of the motility of the proximal and distal segments. The relation of ileal motility to colitis has been developed by Kantor. He shows that a functional defense reaction of spasm of the ileocecal sphincter occurs.

Shortly before White presented the roentgenological attributes of the appendix, Mills described the roentgenographic pattern of the small intestine which indicates a past or coincidental peritoneal irritation. These are atypical, patchy, irregular, discrete loops of small intestine and they vary in definition according to the degree of the original disturbance which may be conceived as ranging from a congestion of the peritoneum to a peritonitis. Mills asserted these irritation forms to be roentgenological evidence of the

THE TREATMENT OF POSTOPERATIVE TETANY WITH SPECIAL REFERENCE TO THE ADMINISTRATION OF IRRADIATED ERGOSTEROL<sup>1</sup>

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THE realization that continued toxicity following thyroidectomy for thyrotoxicosis must have its source in residual abnormally functioning thyroid tissue has resulted in a trend toward more radical resection. With adequate excision, the incidence of failure to afford complete and lasting relief has fallen to a very low figure, but unfortunately there has been some increase in the frequency of parathyroid injury. Transient objective evidences of parathyroid damage may be detected in a rather large proportion of cases in which a maximal operation has been performed. These are usually of little importance, being associated with no subjective symptoms whatever, or with mild discomforts readily controlled and disappearing within a few weeks or months after operation. On the other hand, the more severe and lasting cases of manifest tetany constitute perhaps the most unfortunate sequelæ of thyroid surgery. These patients may be reduced to years of partial invalidism, disturbed by frequent spasms and paræsthesias, exhausted by prolonged adherence to a disagreeable regimen, and menaced by the danger of generalized convulsive seizures and cataract formation, with no certainty of eventual spontaneous improvement.

Recent years have pointed the way to methods which may be useful in the prevention of serious parathyroid deficiency. Millner has called attention to the frequent occurrence of parathyroid bodies on the lateral and even the anterior thyroid capsule and has suggested modifications in technique designed to preserve these structures. Lahey has introduced the method of identifying parathyroid tissue in the removed specimen at operation and of transplanting such bits into the sternomastoid, and Cattel has recently presented experimental proof for the adequacy of such autotransplants. Discouraged by the difficulty in accurately recognizing parathy-

roids in such specimens, we have made little use of this method.

The active management of the more severe and persistent cases of tetany may present a most difficult problem in therapeutics. The basis for the active treatment of parathyroid tetany is the fundamentally important fact that extirpation of the parathyroid glands is followed by a drop in blood calcium, and that in general measures which tend to restore a normal calcium level simultaneously bring about evidences of clinical improvement. Of the measures available to restore the normal level of blood calcium, the one of greatest practical importance is the oral administration of calcium salts. The efficacy of this method, first suggested by Frouin for the control of experimental tetany, has had adequate demonstration in the work of Luckhardt and Goldberg, and Hjort has provided chemical support for the physiological observations made by these authors. The capacity of various orally administered salts to elevate the blood calcium is now established on a firm experimental basis (Jansen, Hjort, Roe and Kahn). Past failures to demonstrate such an elevation must be attributed to inadequate dosage, or to the determination of blood calcium in specimens drawn after time has been allowed for a return to the pre-ingestion level (Hjort). Of the salts available for this purpose, calcium lactate, because of its adequate solubility, ease of administration, and the readiness with which it is absorbed, has found the most extensive practical use. The problem of establishing the optimum dosage for the oral administration of calcium lactate is as yet unsolved. Roe and Kahn have demonstrated that the maximum degree of calcium absorption occurs from amounts not exceeding 5 grams. It is important, however, that these observations were made on normal human subjects. We have repeatedly observed instances of severe tetany, particularly

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hypodermic injections are serious practical objections to its use over long periods of time. Furthermore, the observation has recently been made by Albright, Bauer, Ropes, and Aub, that patients may develop an immunity to this agent, so that it becomes ineffective with repeated administration. We have ourselves observed 1, and possibly 2 cases in which such immunity seemed to be acquired. A case in which parathormone was entirely without benefit unless given together with thyroid extract, orally administered, has been reported by Hjort and Eder. Homotransplantation of parathyroids has yielded few gratifying results. The difficulty in obtaining material, the frequency of complete failure to afford relief, the transiency of improvement in those isolated instances in which it has been alleged to occur, are all factors which have discouraged extensive recourse to this measure. One of our patients received a single transplant without clearly demonstrable improvement. Unfortunately, no preparation of parathyroid, which is consistently effective when given by mouth, is available. Obviously, such a preparation would constitute a final and ideal solution of the problem.

We have had no extensive experience with the various other measures which have been suggested for the control of parathyroid tetany. Kaolin has not been used except to control the diarrhoea following calcium lactate or lactose administration. We have not employed ammonium chloride. Favorable results have been obtained with it in experimental tetany by Boyd, Austin and Ducey, and Werner, and Freudenberg and Gyorgy report its successful use in one case of human post-operative tetany.

It becomes evident from this discussion that there is a serious need for some simple adequate method for the control of tetany, particularly for those cases in which management must be continued over a considerable period of time.

During recent years, it has been demonstrated that infantile rickets and tetany can be controlled clinically and chemically by the administration of cod liver oil. It was subsequently shown that exposure of such patients to sunlight or to ultraviolet irradiation was

followed by similar improvement. In the series of investigations which followed, figuring most prominently the names of Steenbock, Hess, Windaus, Rosenheim and Webster, these facts were strikingly correlated. It was found that various foodstuffs could be rendered antirachitic by irradiation, that the activation so conferred was localized in the lipoidal constituents, such as the sterols and closely related compounds, and finally that the specific agent so activated could be separated from cholesterol itself. This substance was finally identified as ergosterol—a sterol widely distributed in plant life. Ergosterol, activated by irradiation, is at present regarded as the antirachitic vitamin, or vitamin D, and has received the name of viosterol. To its presence is attributed the activity of cod liver oil, and the effectiveness of ultraviolet light has been accounted for by the production and absorption of vitamin D from the skin following irradiation.

The efficacy of irradiated-ergosterol in infantile tetany has been firmly established by clinical investigation (Hess and Lewis, Gyorgy, Prinke, Bakwin, Bakwin and Gottschall, and others). The administration of adequate doses results practically without exception in complete clinical improvement, with a restoration of normal blood chemistry. Furthermore, Hottinger has reported the successful use of irradiated ergosterol in several cases of spontaneous tetany in adults. The success of this treatment in spasmophilia and spontaneous adult tetany, conditions so closely related clinically and chemically to parathyroid tetany, led us to consider its use in the more prolonged and severe cases of post-operative tetany in human beings. Two practical advantages for this method presented themselves. In the first place, the administration of adequate doses of irradiated ergosterol incorporated in foodstuffs or dissolved in oil, is simple and not disagreeable. Second, the observation of Hess and Lewis that the elevation of blood calcium following its administration may be present for longer than 30 days after the discontinuation of the drug, led us to hope that complete control of tetany might be obtained by intermittent administration, with periods of complete freedom from

during periods of acute exacerbation in which massive doses measured in ounces, not grams, have apparently been necessary to control symptoms. On more than one occasion during such crises we have had to administer calcium lactate in amounts approaching the minimum of 15 grams per kilogram, found by Luckhardt and Goldberg, to be required for the control of tetany in completely parathyroidectomized dogs. Frouin also used large quantities of calcium (5 to 10 grams of calcium chloride in 24 hours) and the necessity of employing such doses has been emphasized by Hjort and by Dragstedt and Sudan.

Even massive doses of calcium lactate can be taken with relative ease. We have found it convenient where large quantities must be taken for some time to instruct patients to dissolve the entire day's ration at once by heating in water, flavoring the solution with fruit juices and taking divided doses of the mixture during the day. We have heeded the suggestions of Roe and Kahn that the salts be always given in solution and at a time when the stomach is relatively free of food. Such a regimen is fairly simple and the problem would seem to be solved in a satisfactory way were it not for the fact that the administration of large doses of calcium lactate by mouth for any considerable period is found almost invariably to be followed by nausea, abdominal pain and diarrhoea. With the appearance of these symptoms, we have been accustomed to resort to injections of parathormone or to switch to some less irritating calcium salt. Under these conditions we have frequently prescribed calcium carbonate. The grittiness of this insoluble powder, when taken in large doses in suspension, is disagreeable to the average patient. We have had at least one patient in whom the continued ingestion of calcium carbonate was followed by symptoms of gastro intestinal irritation. Furthermore this substance must depend upon the acids of the gastric juice for solution, and hence it may be ineffective in subjects with lowered or absent gastric acidity. We have occasionally given the carbonate in combination with calcium lactate to check the diarrhoea produced by the latter, and used in this way it has been of distinct value. The irritating properties of

calcium chloride prohibit its use in adequate doses. We have as yet had little experience with calcium gluconate. In 3 cases we have seen a severe diarrhoea follow its use in large amounts and Szurek has observed similar symptoms following the administration of large doses of calcium gluconate to dogs. The diarrhoea from calcium gluconate may also be conveniently checked by moderate amounts of calcium carbonate. Intravenous calcium injections are of use only in the treatment of acute symptoms, and here, because of its safety, calcium gluconate has superseded the other calcium salts. In 2 patients we have employed intramuscular injections of calcium gluconate. One patient has been giving herself such injections whenever active symptoms have threatened.

To supplement the oral administration of calcium, lactose has been given by mouth. This measure has its origin in the observations of Dragstedt and his collaborators that tetany can be prevented in parathyroidectomized dogs by diets of milk, bread, and lactose. Evidence has been presented by Irving and Ferguson to the effect that the degree of calcium absorption from the intestine is a direct function of the acidity of the medium in which it is introduced. Thus, the efficacy of lactose may be attributed to the aciduric flora produced and the consequent facilitation of calcium absorption. Evidence that lactose given by mouth increases the absorption of calcium has been presented by Berghem, and Greenwald has recently shown that lactose protects against tetany only if large amounts of calcium are contained in the diet. It would seem, therefore, that increasing the dosage of calcium would constitute a more direct measure than the addition of lactose to the diet. The dietary outlined by Dragstedt, with its resulting severe diarrhoea, is obviously not available as a practical clinical measure.

Substitution therapy for parathyroid deficiency is still on a most unsatisfactory basis. Parathormone is of great value for the relief of acute symptoms, and may be invaluable to tide severe cases over periods during which adequate doses of calcium by mouth cannot be tolerated. Its expense, and the inconvenience of a method of sustaining life by frequent

Stern His patient presented a severe postoperative tetany of 15 years' standing which had had its onset 2 weeks after a goiter operation. The manifestations were severe, with repeated attacks of generalized convulsions and trophic disturbances of the hair and nails. Cod liver oil, parathyroid preparations, ultraviolet irradiation, and a parathyroid transplant had been without material or lasting effect. Irradiated ergosterol in the form of vigantol was administered in doses of 3 to 4 milligrams three times daily, with the surprising result that in 2 weeks there was marked clinical improvement which amounted at the end of 6 weeks to practically a complete symptomatic and objective cure. Deming, on the other hand, has had completely negative results with irradiated ergosterol in several cases of human postoperative thyroid tetany, and Elmer and Scheps have reported one case of human postoperative tetany, which was entirely refractive to vigantol.

We wish briefly to present a series of observations on the administration of irradiated ergosterol (in the form of acterol) to 6 patients with postoperative tetany. These patients, all of them women, ranged in age from 24 to 31 years. Thyroidectomy had been performed in each case for thyrotoxicosis from 2 months to 5 years previous to the period of observation. In one case operated upon elsewhere, the diagnosis of hyperthyroidism had not been clearly established, and we have no exact record of the operative procedure. In the 5 remaining patients, a maximal excision had been performed. Tetany in each case appeared within a few days following operation. Four of these patients presented mild active tetanic manifestations and the remaining 2 are to be classified as cases of severe tetany. Every case had been shown previous to or during the period of these observations to be amenable to the calcium therapy. Patient A P presented the most severe and persistent symptoms, and had been a trying problem to us for a period of years. It was upon this patient that a parathyroid transplant had previously been performed with questionable benefit. Five of the 6 cases observed were made accessible to me through the kindness of Dr. H. M. Richter, at whose instigation this study was undertaken.

#### METHODS

The practical difficulties in evaluating any method of therapy in a condition as labile as parathyroprival tetany will be readily appreciated by those who have had an opportunity to observe such cases. The frequent and constantly altering discrepancies between objective, subjective, and chemical manifestations, the constant fluctuations in severity with menstruation, pregnancy, infections, deliberate or accidental breaches in diet, and frequently without respect to any recognizable external factors, necessitate the most conservative and painstaking observation before justifiable conclusions can be drawn.

Examinations were made as nearly as possible once weekly. The criteria chosen for study were the subjective manifestations of stiffness, spasms, and paræsthesias, the objective evidences of increased neuromuscular irritability—which were here restricted to Chvostek's and Trousseau's signs, and estimations of the inorganic phosphate and calcium of the blood. The determination of the electrical excitability of the peripheral nerves (Erb's sign) was omitted because of the disagreeableness of the procedure to most patients. Nevertheless Erb's sign, when elicited under proper conditions, is perhaps the most reliable and consistent clinical index of the degree of parathyroid deficiency. An attempt was made to follow Chvostek's and Trousseau's signs in a roughly quantitative way, so that comparisons in intensity could be made. In eliciting Chvostek's sign, the division into degrees as suggested by v. Frankl-Hochwart, was in part adopted. Contraction of the eyelid, nose, and corner of mouth elicited upon tapping over the facial nerve just anterior to the external ear, was recorded as Chvostek I, of the nose and mouth or of the mouth alone upon tapping beneath the zygoma, Chvostek II. Chvostek I is regarded as more significant than II and may not be present in milder cases. The intensity of response was further recorded as 1 to 4 plus. The fact that Chvostek's sign has been found positive in conditions other than tetany does not reduce the value of this finding as a criterion of the severity of tetany in cases in which it has appeared definitely after operation, together with other

the annoyance of any type of management. We were not frightened by reports of the toxicity of this agent (Kroetz, Pfannenstiel, Kreitmair and Moll, Harris and Moore, Smith and Elvov, Klein, and others). The production of injurious effects in animals by a deliberate huge overdosage is of no practical therapeutic importance. We are in agreement with Hess, Lewis and Rivkin that "too much has been made of these studies."

The literature on the use of vitamin D in its various forms in parathyroid tetany, yields much conflicting, and on the whole, discouraging evidence. Reports on the effect of vitamin D on experimental parathyroid tetany in animals have been made by several investigators. Swingle and Rheingold found that exposure of parathyroidectomized dogs to ultraviolet light greatly prolonged the life of such animals and brought about a striking amelioration of the violent symptoms. The animals, nevertheless, finally succumbed from tetany or exhaustion. Similarly, Pincus, Peterson and Kramer were able somewhat to prolong the lives of parathyroidectomized dogs by ultraviolet irradiation. During the following year it was reported by Jones that the daily administration of 20 cubic centimeters cod liver oil for 2 weeks before operation prevented tetany and greatly increased the life of parathyroidectomized dogs. The administration of similar doses only after operation was without effect. Gates and Grant were able to prevent tetany following the removal of the external parathyroids in rabbits by repeated exposure to ultraviolet rays previous to operation, and Jung found that a favorable effect was exerted by ultraviolet radiation in rats when exposures were made beginning several days previously or from the day of operation. Brougher reported that cod liver oil delayed the onset and ameliorated the symptoms of tetany in parathyroidectomized dogs. Subsequently irradiated ergosterol in the form of acterol was found to exert a favorable effect on the course of tetany in dogs when administration was begun on the day of operation. Attempts to control active tetany by intramuscular and intravenous injections of acterol were unsuccessful unless made in conjunction with administration of large

amounts of milk by stomach tube. Wade has recently reported results similar to Brougher's, cod liver oil being used before operation. In contrast to these somewhat encouraging reports, Urechia and Popoviciu were unable to note any appreciable benefit from irradiated ergosterol on parathyroid tetany in dogs, and Greenwald was entirely unable to confirm the favorable results obtained by Jones with cod liver oil. This author also unsuccessfully attempted to control active tetany in dogs by the administration of massive doses of irradiated ergosterol. Hess and Sherman failed entirely to affect favorably the course of experimental tetany in dogs with large doses of irradiated cholesterol, and in a single experiment by Hess, irradiated ergosterol afforded no protection when administered to a parathyroidectomized monkey, although tetany produced by a low calcium diet previous to parathyroidectomy in the same animal, had been effectively controlled by this agent. Later Hess, Weinstock, and Rivkin reported further experiments in monkeys and dogs, in which the blood calcium could not be elevated markedly by irradiated ergosterol, following parathyroid extirpation. More recently, however, the same authors have succeeded in elevating the blood calcium in parathyroidectomized animals using from 100 to 800 times the therapeutic dose.

The literature reveals few instances of the employment of vitamin D in the treatment of postoperative tetany in human beings. Jackson, in 1927, reported apparently distinct benefit from ultraviolet irradiation in a case of postoperative tetany of 2 years' standing. Brougher recorded 3 cases of human postoperative tetany which were treated with apparent success by the administration of cod liver oil, and has recently reported the successful treatment of these 3 cases and a fourth with small doses of viosterol. The remarkably prompt return of symptoms following the withdrawal of the drug (in 1 case even a day's omission led to a recurrence of symptoms) leads one to question the rôle of viosterol in the improvement observed. A more convincing, though not entirely conclusive, case of human postoperative tetany successfully treated with irradiated ergosterol is that of

a carpal spasm developed practically immediately upon applying constriction to the arm. After 66 days acterol was withdrawn and during the following 5 weeks there was no material clinical change. At the end of this period, symptoms again became more marked, and a second course was again followed by apparent improvement. After 3 weeks of rest, this patient was placed on a third course of acterol, this time in considerably larger doses, in the hope of obtaining a more clearly defined result, and for the third time definite improvement appeared to ensue. Thus, on July 17, 1929, when the final course of treatment was started, the patient was menstruating, and objective and subjective evidences of tetany were present. On October 15, 1929, when the drug was stopped, the patient was again menstruating, but she was symptom-free, and the objective signs were distinctly less pronounced.

The 2 remaining cases offer similar difficulties in interpretation. In Case 5, distinct improvement followed upon the administration of calcium, and persisted when acterol was given and the calcium intake rapidly reduced. After 4 weeks of acterol, however, Chvostek's and Trousseau's signs were still positive, although there were no subjective symptoms of tetany. About 17 days after the withdrawal of acterol, there was a return of mild symptoms. At this time, a second course of acterol alone was again followed by both subjective and objective improvement. Nevertheless, after  $3\frac{1}{2}$  weeks of acterol alone, Chvostek's and Trousseau's signs were still positive. Acterol was now discontinued for the second time, and during the following 6 weeks, there were no tetanic symptoms. At the end of this period, there was a recurrence of very mild disturbances.

In the last case, as in the preceding one, acterol and calcium were given simultaneously. The improvement which promptly followed, again appeared to persist in spite of a rapid reduction in calcium intake. Nevertheless on July 28, 1929, after 10 cubic centimeters of acterol had faithfully been taken daily for a period of 52 days, the beginning of a menstrual period was attended by tingling and mild carpal spasms, and 2 days later, in spite

of small doses of calcium, Chvostek's and Trousseau's signs were mildly but distinctly positive. The complete withdrawal of calcium 2 weeks later was followed by a week's freedom from trouble, but moderate symptoms then returned, and on August 20, 1929, after 74 days of acterol, Chvostek's and Trousseau's signs were again positive. The withdrawal of acterol at this time was followed in a few days by a gradually intensifying train of symptoms, culminating in a severe attack of tetany 2 weeks later. The relationship of this return of symptoms within so short a period after the withdrawal of acterol must again be regarded as questionable.

To summarize, in the 2 severe cases of tetany observed, the administration of irradiated ergosterol in large doses was without appreciable benefit. In 3 of the remaining 4 milder cases, some degree of improvement appeared to follow the administration of this agent. In 1 of these (Case 4) such improvement ensued with three successive courses of treatment.

Blood calcium and phosphate determinations were made as frequently as possible during the course of these observations. Because of certain inconsistencies in the figures we wish to defer their publication until further data have been obtained.

#### DISCUSSION

While the interpretation of the apparent benefit resulting from irradiated ergosterol in 3 of our 4 mild cases is exceedingly difficult, the rôle of irradiated ergosterol in this improvement cannot be entirely excluded. On the other hand, it is to be pointed out that in no case did this agent afford the complete and striking relief following its use in infantile tetany or following adequate calcium administration in parathyroid tetany. This failure may throw some light on the mechanism by which vitamin D exerts its effect. Two theories are available to explain the relief afforded by vitamin D, variously administered, in infantile tetany and rickets. One is based on the repeated observation that this agent decreases the hydrogen-ion concentration of the intestinal content, and thereby facilitates calcium absorption (Zucker and Matzner, Abrahamson

indisputable tetanic manifestations (Chvostek, Pavel, Claudon and Carnateanu)

Trousseau's sign was always elicited by means of a blood pressure cuff pumped up to approximately the same pressure at each observation. The intensity of the spasm which developed and the time required for its development were recorded. This sign—elicited in such a manner—is a fairly sensitive clinical index and on the whole seems more significant and reliable than Chvostek's sign.

An attempt was made to obtain blood for calcium and phosphate determinations weekly and specimens were drawn as closely as possible to the time of clinical observation. In these cases in which calcium was being taken along with the acterol, blood was always drawn at least 15 hours and usually a longer period after the last ingestion of calcium—a period theoretically long enough to permit a return to the pre ingestion level.

Irradiated ergosterol was administered in the form of acterol.<sup>1</sup> At the outset small doses were used, but these were rapidly increased, so that in some cases the equivalent of as much as 10 milligrams daily, was given. For the administration of the larger doses, preparations of three to ten times the strength agreed upon by the council on pharmacy and chemistry for the marketing of viosterol, were made available to us. We have observed no toxic effects from the amounts used.

### RESULTS

The details of these experiments are presented in the records. In the cases of severe tetany studied (Cases 1 and 2), the administration of acterol was followed by no material subjective or objective improvement. In the first of these cases, the experiment was continued over a period of 14 weeks the dose being gradually increased, until approximately 10 milligrams (3 cubic centimeters of a 1000 D preparation) were being taken daily. The results are complicated somewhat by the patients' insistence upon an irregular and haphazard calcium intake. Still at no time, except perhaps during the week beginning on June 25, 1929, was there even appar-

ent clinical improvement. In the second, in which operation had been performed only 2 months previous to these observations, 3 cubic centimeters of a 1000 D preparation were given for a period of one month. While the patient had been able to reduce her calcium ration somewhat during this period, she was still suffering from active manifestations of tetany at the time when irradiated ergosterol was discontinued, in spite of repeated parathormone injections, large doses of calcium, and a carefully restricted diet.

In the 4 remaining and milder cases, results were considerably more variable—in all probability because of spontaneous fluctuations in severity. The interpretation of these experiments, therefore, presents serious difficulties. Thus, in Case 3, the patient insisted that she started to improve almost immediately upon being put on small doses of acterol. Spasms and tingling occurred less frequently and were much milder than before and objectively there were slight evidences of improvement. Symptoms became more severe almost immediately upon the discontinuation of the drug, but such an exacerbation can hardly be attributed to this factor in view of the sustained action of irradiated ergosterol following withdrawal, as observed by Hess and Lewis. Furthermore, when after a week of rest, the same patient was given considerably larger doses (45 minims of a 1000 D preparation) over a period of 4 weeks, there was no material clinical evidence of improvement. Thus, we are forced to regard the result as a negative one. It is of interest that this patient presented a strongly positive Chvostek before operation which had been unaccompanied by other evidences of tetany.

In our second mild case (Case 4) symptoms were confined largely to menstrual periods. During the period having its onset several days after the beginning of acterol administration, objective and subjective evidences of tetany were pronounced. Following the menstrual period there was rapid improvement and during the next menses there were no active tetanic symptoms. Nevertheless, several days later, when the patient stated with emphasis that she was "decidedly better," Chvostek's sign was briskly positive, and

<sup>1</sup>Supplied through the courtesy of Mead Johnson & Company

## CASE II

Date	Numb- ness and tingling	Spasms	Chvostek	Trous seau	Treatment and remarks
8-7-29	1+	0	I & II 0	1+ 90 sec	Calcium lactate 60 gm daily Parathormone 1 c cm daily Superactrol (1000D) 45 m daily started.
8-14-29	0	0	0	1+ 2 min	Parathormone 1 c cm daily Calcium lactate reduced to 30 gm daily Has had some twitching of facial muscles Superactrol continued
9-2-29	4+	4+			Reported much twitching of hands necks sitting additional parathormone injections Calcium lactate and superactrol continued as above
9-6-29	4+	4+			Reported marked twitching and frequent severe carpal spasms in spite of calcium lactate 45 gm daily parathormone 1 c cm and superactrol 45 m daily Acterol has been taken for 1 month Stopped

Note—This patient later appeared to become refractive to parathormone and presented a most difficult problem in management. She is at present entirely controlled on 50 gm of calcium gluconate daily supplementing with occasional intramuscular injections and controlling any tendency to diarrhea with calcium carbonate.

birth After 2 or 3 weeks of apparent marked improvement, symptoms returned with about their former intensity. On April 2, 1928, a diagnosis of pregnancy was made, and the patient remained entirely free of tetanic symptoms throughout pregnancy, being delivered of a normal infant at full term. This remarkable improvement persisted until March 1929, when all of the previous manifestations of parathyroid deficiency returned.

CASE 2 G O, aged 25 years. In 1921 a thyroidectomy was performed elsewhere for hyperthyroidism. Operation was followed by distinct improvement, but relief was not complete. After about 4 years, symptoms began to increase in severity. In March, 1924, there was an acute attack of tetany, relieved by a "hypodermic" and calcium chloride. The administration of calcium chloride was continued for several months. There were no further manifestations of tetany, except for occasional slight fibrillary twitchings of the small muscles of the hands. The basal metabolic rate on May 20, 1929, was 60 plus. On June 4, 1929, a second operation was performed. No thyroid tissue could be found on the right side, but a large mass, friable and obviously hyperplastic, was removed on the left—with care to avoid injury to the posterior capsule. The postoperative course was uneventful until the seventh postoperative day, when there was a severe attack of tetany, relieved by an injection of parathormone.

## CASE III

Date	Numb- ness and tingling	Spasms	Chvostek	Trous seau	Treatment and remarks
4-25-29	3+	3+	I & II 4+	4+ (violent) 1 min	Acterol 30 m daily—started Taking no calcium Blood cal—6.8
5-13-29	3+	2+	I & II 4+	4+ at once	Spasms less severe not less frequent. Acterol increased to 50 m daily
5-28-29	2+	2+			Symptomatically improved not examined on this day Acterol 50 m continued
6-5-29	1+	0	I & II 1+	1+ 45 sec	Occasional stiffness in fingers Acterol to 1 c cm daily continued
6-11-29	1+	0			Unable to report for observation
7-9-29	1+	0	I & II 3+	1+ 75 sec	Acterol 10 c cm daily continued Had slight tingling during menses 3 weeks ago
8-16-29	2+	2+	I & II 4+	4+ 25 sec	Acterol 10 c cm daily stopped on 8-20-29 after 74 days. Menstruating today Moderate tingling and spasms since last visit Superactrol (1000D) 40 m daily started
8-27-29	0	3+	I & II 4+	2+ 30 sec	Superactrol continued as above
9-17-29	2+	4+ frequent and severe	I & II 4+	4+ 20 sec	Superactrol—40 m daily taken until yesterday—total of 40 days

Similar attacks occurred subsequently at frequent intervals, and could be prevented only by massive doses of calcium and daily parathormone injections. Blood calcium on June 27, 1929, was 6.7.

CASE 3 P K, aged 30. When first seen by us on January 13, 1927, Chvostek's sign was strongly positive, but Trousseau's sign was negative after 2½ minutes of constriction. There had never been any numbness, tingling, or stiffening. On February 5, 1927, a maximal thyroidectomy was performed. On the following day, stiffness and fibrillary twitching of the facial musculature were present and Trousseau's sign had become strongly positive. These symptoms recurred and were relieved by parathormone injections and moderate doses of calcium. Patient was discharged on a ration of 12 teaspoonfuls of calcium lactate daily. She was lost sight of for about 2 years and returned on March 21, 1929. At this time she stated that numbness, tingling and spasms were continuing to occur at frequent intervals, particularly just before menses. No calcium was being taken, and no dietary restrictions were observed.

CASE 4 L S, aged 31 years. Maximal thyroidectomy performed on May 12, 1928. Chvostek's sign



and Miller, Yoder, Grayzel and Miller, Jephcott and Backarach, Bauer and Marble) The other theory has its source in the reports of Grant and Gates that ultraviolet light produces a true parathyroid hyperplasia with an increase in potential functional capacity. In harmony with these observations are the reports of Nomdez and Goodale, and Higgins and Sheard. Were direct stimulation of the parathyroids the basis for the activity of vitamin D, some benefit should have followed in all of our patients, since it may be assumed that in no case, even the most severe, had a complete parathyroidectomy been performed. We are more inclined to feel that the essential failure of irradiated ergosterol in these experiments, indicates that this agent produces its effect entirely independently of the parathyroids, and that the changes brought about by its administration are fundamentally different from those needed to combat the group of conditions resulting from parathyroid extirpation. Thus, the analogy between parathyroid tetany and infantile and spontaneous adult tetany, which is so complete with respect to clinical and chemical manifestations, must stop when these similarities have been pointed out. The failure of vitamin D therapy may be regarded with Gyorgy as an important therapeutic test establishing a profound and fundamental difference in the pathogenesis of these conditions.

#### SUMMARY

Six cases of human postoperative tetany treated with irradiated ergosterol (acterol) are reported. In the 2 more severe cases of the series, no improvement resulted from the use of this agent. In 3 of the 4 remaining cases, variable degrees of improvement, in which the role of irradiated ergosterol could not entirely be excluded, appeared to ensue. It is felt that these observations do not sustain the view that the action of vitamin D occurs through the agency of the parathyroid bodies.

Case 1. A P. aged 24 years, had a maximal thyroidectomy performed on September 27, 1924. Chvostek's and Trousseau's signs were positive on the following day, and soon after the patient developed severe carpal spasms, numbness and tingling of fingers, and stiffness and twitching of the facial muscles. These symptoms recurred and were

#### CASE I

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
4-22-29	4+	4+	I & II 4+	4+ 50 sec	Calcium lactate—45 gm daily (Blood Ca—6.2) Acterol—50 m daily
4-25-29	4+	4+			Menses. Taking large amounts of calcium lactate several ounces daily
4-30-29	4+	4+	4+	4+	Acterol increased to 60 m daily. No carpal spasm since 4-25 a m
5-10-29	4+	0			Calcium lactate 60 gm daily on the average. Acterol continued 60 m daily
5-11-29	4+	4+			Acterol increased to 10 c cm daily
5-13-29	4+	4+	I & II 4+	4+ 25 sec	Calcium lactate about 30 gm daily—much more necessary during last menses. Acterol continued to 5 cm daily
6-11-29	4+	4+	I & II 4+	4+ 10 sec	No calcium for 2 days. Acterol 10 c cm daily
6-19-29	4+	4+	I & II 4+	4+ 50 sec	Calcium about 30 gm daily. Acterol 10 c cm daily continued
6-25-29	4+	0		4+ 2 min	On 15 gm of calcium carbonate daily. On acterol 10 c cm daily—2 weeks
7-2-29	4+	0	4+	4+ 50 sec	Calcium carbonate 30 gm daily. Acterol continued as above
7-9-29	4+	4+	I & II 4+	4+ 1 min	Troubles returned on 7-9-29. Took calcium lactate 60 gm daily for several days. Acterol to 5 cm daily continued
7-16-29	4+	4+	I & II 4+	4+ 1 min	Supracterol (1000 ft) 45 m daily started on 7-16-29. Calcium lactate 30 gm daily
7-29-29	4+	4+			Having much trouble in spite of 8 tablets supraterol of calcium lactate and 45 m of supraterol daily
8-6-29	4+	4+	I & II 4+		Has had supraterol 45 m daily for 24 days. Severe carpal spasm present during examination

kept under control as well as possible by orally administered calcium, parathormone injections and lactose with frequent alterations in regimen to meet new indications and parallel fluctuations in severity. On October 24, 1927, a parathyroid transplant was performed, material being obtained from a still

## CASE VI

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
6-6-29	2+	2+	1+	1+ 1 min	Calcium lactate 8 drams daily and acterol 10 ccm daily—started today Blood Ca—7.1
6-12-29	0	0	0	0	Has been taking calcium lactate about 4 oz daily Reduced to 8 drams daily Acterol 10 ccm daily continued
6-19-29	0	0	0	0	Calcium lactate and acterol continued as above
6-25-29	0	0	0	0	No calcium since 24 hours before examination Calcium lactate reduced to 4 drams daily Acterol—10 ccm daily
7-8-29	0	0	0	0	Not examined on this day Calcium lactate 2 drams daily
7-16-29	0	0	0	1+ 2 min	No calcium for 28 hours Calcium lactate 1 dram daily Acterol 10 ccm daily continued
7-23-29	0	0	0	0	Calcium stopped Acterol 10 ccm daily—continued
7-30-29	2+	2+	1+ 11 0	1+ 45 sec	Since beginning of menses on 7-28 has had tingling and mild carpal spasms relieved by small doses of calcium lactate No calcium during last 28 hours To take calcium lactate one dram daily for a few days Has been on acterol 10 ccm daily for 54 days To continue
8-6-29	0	0	0	1+ 2 1/2 min	Has continued calcium lactate 1 dram daily until today Quies tingable twitching of neck muscles 1/2 per day To stop calcium again and continue acterol 10 ccm daily
8-13-29	0	0	0	0	No calcium for 1 week—free from symptoms Not examined
8-20-29	1+	0	1+	1+ 1 min	Numbness in right arm on 8-15 16 17, relieved by small doses of calcium Various complaints during last few days—weakness faintness dizziness pain in head Sodium bromide—45 grains daily Acterol stopped—(10 ccm daily taken for 10 weeks) No calcium

## CASE VI—CONTINUED

Date	Numbness and tingling	Spasms	Chvostek	Trousseau	Treatment and remarks
9-3-29					Numbness and tingling recurred several days after last visit—increasing in severity in spite of small doses of calcium Today seen in violent carpopedal spasm—relieved promptly by calcium gluconate 4 drams orally Calcium lactate 8 drams daily started
9-14-29	0	0	0	0	Calcium lactate 6 drams daily
9-21-29	0	0	0	0	Continues calcium lactate 6 drams daily No symptoms
10-29-29	1+				Tingling all over since beginning of menses on 10-26 Not examined
11-5-29					Carpopedal spasm 3 weeks ago No trouble since On calcium lactate 6 drams daily

occurred until June 14 1928, when the onset of a menstrual period was accompanied by stiffness and numbness of the fingers and definite carpal spasms Chvostek's and Trousseau's signs at this time were strongly positive Numbness, tingling and stiffness continued to occur during menses, in spite of moderate doses of calcium and a meat free diet There was relatively little trouble between menstrual periods

CASE 5 R G, aged 24 years A maximal thyroidectomy was performed on April 15, 1927 Patient began to complain of numbness and tingling in hands and feet after leaving hospital, and examination revealed positive Chvostek's and Trousseau's signs On small doses of calcium, subjective symptoms almost entirely disappeared, although Chvostek's sign remained positive From March 2, 1928, to November 15, 1928, no calcium was taken, and there were no subjective manifestations of tetany At about the latter date, numbness and tingling returned, promptly disappearing when treatment was started again, and reappearing when treatment was again discontinued

CASE 6 B S, aged 31 years A thyroidectomy was performed elsewhere 2 years ago The details of this operation are not available On the seventh day after operation, patient began to complain of numbness and tingling and stiffness of the facial muscles, and carpopedal spasms occurred These symptoms have been recurring at intervals of 1 or 2 weeks since, and have been particularly noticeable during menses She has never been on an adequate and careful regimen

CASE IV

Date	Num- bers and tingling	Spasms	Chvostek	Trous- seau	Treatment and remarks
4-25-29	None re- cently	None re- cently	I & II 2+		Aterol 30 m. daily started No calcium being ta- ken Blood Ca → 7.8
4-30-29	4+	4+	I & II 4+	4+ 10 sec (Slight spasm before ap- plication of cuff)	Menses began on this day Symptoms more marked than in last few periods Calcium carbonate—8 drams daily Aterol increased to 30 m. daily
5-3-29	Reported	as mu- ch better			Calcium stopped
5-14-29	1+	None since one 5-6	I & II 1+	1+ 30 sec	Aterol 60 m. daily No calcium
5-23-29	0	0	I & II 1+	1+ 45 sec	Aterol 10 c cm daily started.
6-5-29	1+	0	I & II 3+	2+ almost at once	Does ledly better — no symptoms what- ever during men- strual period (i.e. 5-25 to 5-30). Not free from symptoms during and post op- erative period since opera- tion Aterol 10 c cm daily continued
6-11-29	1+	0	R 1+ I 2	1+ 10 sec	Aterol 10 c cm con- tinued
7-1-29					No symptoms since 6-12 Aterol stop- ped
7-9-29	0	0	R 1+ I 3+		Last menses 7-22 to 7-26 Slight tin- gling no spasms
8-6-29	3+	Some stiff- ness in fingers	I & II 2+	1+ 40-60 sec	Troubles returne ab- solutely Aterol 10 c cm again started
8-11-29	1+	0	I & II 2+	1+ 45 sec	Aterol 10 c cm con- tinued
8-20-29	0	0	I & II 2+	1+ 10-30 sec	Aterol 10 c cm con- tinued
8-27-29	1+	0			Aterol stopped
9-10-29	1+	0	I & II 3+	1+ 60 sec	No medication for 13 days
9-17-29	1+	Stiff- ness No definite spasms	I & II 4+	1+ 10 sec	No medication what- ever for 20 days Patient is menstruat- ing Superactol (good) 8 c cm daily started
9-24-29	1+	0	I & II 2+	1+ 30 sec	Superactol contin- ued as above
10-1-29	1+	0	I & II 1+	1+ 60 sec	Superactol contin- ued
10-8-29	0	0	I & II 1+	1+ 90 sec	Superactol contin- ued
10-15-29	0	0	1+	2+ 45 sec	Menstruating Super actol Stopped after 25 days

CASE V

Date	Num- bers and tingling	Spasms	Chvostek	Trous- seau	Treatment and remarks
6-27-29	2+	1+	1+	1+	Calcium lactate 8 drams daily started
7-2-29	1+	0	I & II 1+	1+ 60-80 sec	Calcium lactate 8 drams daily con- tinued Blood Ca → 7.7
7-10-29					Aterol 10 c cm daily started Calcium lactate 6-8 drams daily
7-17-29	1+	0	I 1+ II 2+	1+ 30 sec	No calcium last night and this morning Calcium lactate re- duced to 3 drams daily Superactol (1000U) 15 m. daily
7-25-29	1+	0	I 0 II 2+	1+ 2 min	No calcium for 36 hours Calcium lac- tate 1 dram daily Superactol 45 m. daily continued.
8-1-29	1+	0	I 0 II 2+	1+ 90 sec	No calcium for 36 hours. Calcium lac- tate 1 dram daily Superactol contin- ued
8-7-29	0	0	I & II 1+	1+ 30 sec	No calcium for 8 days Aterol stop- ped—11 am last ac- terol 7 days super actol 21 days
8-14-29	0	0	0	1+ 1 min	No medication for 1 week States that she has previously been symptom free for 1 or 2 months without treatment. "Not so well for many months"
8-23-29	1+	Stiff- ness of hands facial twitch- ing	I 1+ II 1+	1+ 30 sec	No medication for 3 weeks Mild dis- turbances returned a few days ago Super actol (1000U) 45 m. daily started
9-4-29	1+	0	I 0 II 1+	1+ 10 sec	Superactol 30 m. daily
9-11-29	2+	Slight stiff- ness	I 0 II 1+	1+ 70 sec	Aterol 10 c cm daily Much better Very slight feeling of stiffness in hands
9-17-29	0	0	I 0 II 1+	1+ 80 sec	Aterol 10 c cm con- tinued Practically no trouble Slight stiffness when arm rests in certain posi- tions
9-25-29	0	0	I 0 II 1+	1+ 1 min	Aterol stopped
10-2-29	1+	Occasional twitch- ing about mouth and eye	I 0 II 1+	1+ 2 min & 45 sec	No medication for 7 weeks Mild sym- ptoms returned about 1 week ago

was definitely positive 48 hours after operation and some tingling and stiffness of the fingers appeared on the third day after operation. On moderate doses of calcium lactate no further active symptoms

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resection of the kidney, the patient became pregnant and 7 months later gave birth to a child who lived 14 days

That multiple, consecutive operations may be successfully undertaken on a solitary kidney of good function is further evidenced by the reports of such cases by Babcock, Albarán, Squier, and Hinman and Gibson

Keyes' report of 6 cases in which he had performed operations on a solitary kidney, with recovery in all, is the latest report in the literature In 2 of the cases, multiple operation had been done successfully on a solitary kidney

In 2 cases reported by Rosenkrantz, in which nephrectomy had been done for tuberculosis, external inguinal ureterostomy was safely performed on the ureter of the remaining kidney Recently Coffey described two successful cases of transplantation of the ureter from the remaining kidney into the sigmoid in patients whose opposite kidney had been previously removed for tuberculosis In 1926 Hunt transplanted successfully the ureter from a solitary kidney into the sigmoid for the relief of exstrophy of the bladder Ten days later the bladder, which was carcinomatous, was excised and the patient made a good recovery

The incidence of congenital absence of one kidney was described by Hennessey as occurring once in 1,000 cases, and by Campbell, as once in 1,600 cases This is of interest in view of the fact that in Battle's case left nephrotomy was done for relief of obstructive pyelonephritis in a girl, 18 years of age, whose right kidney was congenitally absent

Numerous cases of operations on the remaining kidney are also to be found in the foreign literature In one of the cases reported by Haebler, in 1920, in which the anuria was the result of stenosis of the ureteropelvic junction, a plastic operation, consisting of resection of the larger part of the pelvis and of the strictured region was done Siedner, in 1925, reported 3 cases from von Lichtenberg's clinic Obstructive suppression of urine in one case was due to a large anomalous renal vein The vein was severed and nephropexy was done because of the low position of the kidney, with complete relief of symptoms A

stone was the offender in each of the other cases Cases have been reported by Chwalla, Rosenstein, Siedner, and Cifuents These authors emphasized the grave importance of the appearance of stone in the remaining kidney after nephrectomy on account of ureteral obstruction and consequent anuria Because of the uncertainty of prognosis in their cases attendant on operations on a solitary kidney, they advocated, first, the passage of a ureteral catheter past the stone Many times this is sufficient to relieve the obstruction When this fails, nephrotomy, in their opinion, is preferable to pelvolithotomy In their experience, the formation of stone in the remaining kidney, after nephrectomy, is of more or less frequent occurrence, and is variously reported at from 3 to 17 per cent Such has not been the experience in the clinics of this country, for example, in 1917, W J Mayo stated "Stone formation or reformation in the remaining kidney after nephrectomy is an uncommon occurrence in our series"

#### COMMENT ON CASES

In the 52 cases from The Mayo Clinic which form the basis of this review, operation was done in the period from November, 1911, to January, 1930 The incidence of operations on the solitary kidney occurred twice as often in males as in females, and in 75 per cent of the cases occurred in the third or fourth decade of life Multiple operations on the solitary kidney were done in 6 cases, in all of which operation was successful Four of these were for recurrent stone

In 45 of the 52 cases, operations were for removal of urinary calculi, the 7 remaining were for conditions other than stone Of the 45 cases of lithiasis, the stone was removed from the kidney in 34 and from the ureter in 11 In this group, there were 6 deaths following removal of stones from the kidney In the 6 cases in which death occurred, operation was undertaken as an emergency procedure when obstruction and infection had manifested themselves to such a degree that immediate operation was necessary In each case, partial renal insufficiency was evidenced by an accumulation of more than 40 milligrams of urea in each 100 cubic centimeters

## OPERATIONS ON SOLITARY KIDNEYS AND URETERS

REPORT OF FIFTY TWO CASES<sup>1</sup>WALTMAN WALTERS M.D., F.A.C.S. ROCHESTER MINNESOTA  
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A REVIEW of the literature reveals numerous reports of operations on the solitary kidney. For the most part, such operations have consisted of removal of calculi or drainage of the kidney by nephrostomy. In such cases, usually, the opposite kidney had been removed previously for stone, hydronephrosis may have been a complication. Recently, the successful outcome following ureteropyeloneostomy for the relief of anuria with hydronephrosis caused by complete obstruction at the ureteropelvic juncture of a solitary kidney, and the successful outcome of pelvolithotomy in 2 cases in which the kidney was solitary, has led to a review of cases in which operations have been performed on a solitary kidney or ureter at The Mayo Clinic. The purpose of the review has been to determine the causes, the risk, and the results of operations in such cases. The group consists of 52 cases in 45 of which operations were undertaken for the removal of stone.

In one of the earliest cases to which reference was found in the literature, operation was done by Ferguson in 1902. The patient, a boy of 8 years, had undergone right nephrectomy in November, 1901. The following month suppression of urine occurred, due to an obstructing stone in the left kidney, for which left nephrolithotomy was performed. Two months later a stone was removed from the urethra by meatotomy and a month later cystostomy was done, and a vesical calculus was removed. Ferguson reported that the patient made complete recovery.

By removing segments of solitary kidneys in rabbits, from which the opposite kidneys had been removed previously, Tuffier determined the minimal amount of renal tissue necessary to maintain life, and estimated that

in man life could be maintained with from 80 to 100 grams of sound renal tissue. Babcock, in 1907, called attention to the clinical fact that one half to two thirds of a single functioning kidney was sufficient to maintain life and that the ability of the kidney to withstand multiple and extensive operations and trauma was due to the power of regeneration and hyperplasia possessed by the organ. Further clinical confirmation of this can be found in a case in which operation was done in 1910 by W. J. and C. H. Mayo and which was reported in 1917. At that time, they stated that they had been impressed with the fact that a person can maintain not only life, but also working power, with what amounts to not more than half of a normal kidney. In support of this, they described the case of a man, aged 44 years, who came with a stone in the remaining kidney 4 years after stones had been removed from the same kidney and nephrectomy had been done on the opposite side. The patient was in a state of uremia, and operation was deemed inadvisable. It was undertaken, however, on the insistence of the family, and the patient made a good recovery. Twice during the next 5 years he returned, was operated on for recurrence of the stone, and returned to his occupation each time.

In the same year, Judd reported a case, that of a woman aged 32 years, in which resection of the upper third of a solitary kidney was done in order to remove an abscess containing stones. Accurate records were kept before and after the operation which show that at the time of operation, renal function was definitely interfered with. After 2 months, the concentration of urea in the blood returned to normal and remained normal thereafter. Five months following this

<sup>1</sup>Submitted for publication April 21, 1930.

been able to find in the literature less than 10 cases in which multiple operations were done on the solitary, remaining kidney. In these cases, together with the 6 herein reported, recoveries occurred in all. This bears out the early experimental observations of Tuffier, and the clinical observations of Babcock and of W. J. Mayo, that some persons can maintain not only life but working power with as little as half of a normal kidney.

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of blood, by excretion of phenolsulphonephthalein of less than 30 per cent in the urine in 2 hours, and by a marked degree of renal infection, as evidenced by the presence of pyuria (pus graded 3 to 4). In each of these cases, failure to recover was the result of loss or absence of renal function in combination with marked renal infection, the patients died in a state of uræmia. Therefore, the necessity of early removal of a calculus in a solitary kidney before the onset of obstruction, of reduction in function, and of anuria with pyelonephritis or pyonephrosis is apparent.

All of the 11 patients from whom stones were removed from the ureter of a solitary kidney recovered. Four of these patients had complete urinary obstruction, two others had had anuria, lasting for 24 hours before admission. Where possible, an attempt to catheterize the ureter was made, and the concentration of blood urea was allowed to diminish before operation. One patient was aged 73 years, another, 50 years. In 8 instances, the stone was lodged in the lower third of the ureter.

In cases in which operation was undertaken for stone, pelvolithotomy was done in 24 instances, ureterolithotomy, in 10, nephrolithotomy, in 7, nephropelviolithotomy, in 2, pelvio ureterolithotomy, in 1, ureteral meatotomy, in 1, and resection of the upper pole of the kidney, with removal of stones, in 1. Since in 45 operations on the solitary kidney or its ureter, for stone, there were 39 recoveries and 6 deaths, the mortality rate was 13.3 per cent.

In 7 cases, operation was done on the solitary kidney for conditions other than stone, there were 3 recoveries. One instance of recovery was in the case in which uretero-pyeloneostomy was done and which has been mentioned previously. In another case, following urinary suppression of 5 days' duration, right pelviotomy was done for acute hydronephrosis with infection, a condition caused by an anomalous renal vessel. The vessel was divided and the patient recovered. Two years previously, the left kidney had been removed because of hydronephrosis with infection. In the third case, permanent nephrostomy was performed in 1920 because

of pyelonephritis. The 4 patients who succumbed had irreparable disease of the renal parenchyma associated with cortical abscesses, in 2, decapsulation was undertaken without benefit. In the 2 other patients, following nephrectomy for tuberculosis, transplantation of the remaining ureter into the sigmoid was done for the relief, respectively, of intense tuberculous cystitis and of scrotal, urinary fistula.

#### COMMENT AND SUMMARY

A review of the literature, and a series of 52 cases from the records of The Mayo Clinic, in which operations were done on the solitary kidney or ureter, would indicate that the risk of death from such operations, undertaken for the removal of stones, was approximately 13 per cent. The operative risk in these cases was the result of delay, during which decreased renal function and renal infection had occurred. Evidence of this is seen in the review of the cases of 6 patients, who died following operations on the solitary kidney for stone. In all of these cases, renal function was abnormally low. In addition, the urine from the kidney in each of these 6 cases contained a maximal amount of pus (graded 3 to 4). Delay in operating on a solitary kidney, until urinary obstruction with anuria had occurred, definitely increased the mortality rate of operations in such cases. The risk of operations on the solitary kidney is dependent on its function and the degree of infection. Results in such cases are somewhat dependent on the size and number of stones present. When the stone or stones are of large size, the possibility of a persisting urinary fistula must be taken into account.

Reports in the literature and a study of cases seen at the clinic would indicate that in the presence of satisfactory function of the remaining kidney, without abnormal infection, multiple operations can be safely undertaken on the solitary remaining kidney, with the expectation of satisfactory results. Although prognosis may seem to be almost hopeless because, as the result of delay, anuria and impending uræmia are present, operation should be undertaken, in cases of this type recovery has occurred. We have

To me, the essential type of adhesions are more interesting than the secondary type because in them we find a spider-web like veil upon the duodenum but no etiologic factor in the duodenum, gall bladder, or stomach

Has this finding any pathological significance?

Duval believes that this veil is congenital and it is of pathological significance only when it causes duodenal stenosis which leads to symptoms Morris, Appel, Arbuthnot Lane, and Deaver believe that the membrane is of inflammatory origin and that a periduodenitis which is localized only to the periduodenal region is responsible for the many symptoms Doberer suggests gastritis as an etiologic factor Zander considers pancreatitis Reischauer holds that adhesions and ulcers are equally responsible together with the nervous disturbances they cause Anapylaxis to specific proteins in the diet is a factor which should be considered in the same light as duodenal ulcers which follow burns He suggests the name "asthma duodenale" for this syndrome of periduodenitis<sup>1</sup> Gregory Cole considers it unimportant whether this membrane is congenital or due to localized inflammation of the peritoneum and thus dismisses the whole subject

I believe, however, that a correct understanding not only of the etiology but also of the practical significance of this condition is not only of scientific but of practical value

In our discussion we shall first consider the clinical findings in periduodenitis In those cases in which the periduodenal membrane is present, I find that the patients always give a history of gastric distress which would seem to be caused by a peptic ulcer, but in which there is always something which makes the picture atypical The patients complain that pain in the epigastrium always follows eating and that this pain develops immediately after taking food The pain has a certain periodicity typical of ulcer, nocturnal pains are less frequent, typical hunger pain is absent, warm milk does not afford complete relief, emesis occurs occasionally and hematemesis is not infrequent all the patients have lost weight, proper dieting does not afford the immediate relief which we have learned to expect in ulcer cases, but rest always alleviates the symptoms If the patient returns to work the symptoms immediately reappear and the psychic factors seem to be important It is interesting to note that there are more young men in this group of patients than women

There are practically no objective findings Usually there is tenderness in the epigastrium a little to the right of the midline, gastric acidity

is usually high, in our series the benzidine test was positive only once the X-ray findings always showed a deformed bulb suggestive of ulcer but in the absence of other X-ray ulcer findings the roentgenologist diagnosed adhesions but could not definitely diagnose ulcer, the stomach itself was normal and there was no retention

The stomach and gall bladder were found at operation to be normal but there was a firm, very red membrane on the duodenum On two occasions I was definitely able to establish the fact that at its distal border the membrane was firmer and exerted mechanical pressure upon the duodenum On another occasion the membrane was so dense that it had stretched the duodenum to its limit In all the other cases, the membrane was so thin that it could not have had any mechanical effect and was responsible only for the hyperæmia or redness with which it was associated

I have observed this membrane for a long time and believe that two different factors enter into its etiology The first is the pericolic or the so-called Jackson's membrane I once believed that this pericolic was of grave pathological significance and consequently when present would frequently resect the colon, which procedure taught me that the membrane had a classic localization—it begins just above the cæcum but does not bind it down, spreads over the ascending colon until it reaches the hepatic flexure, whence it turns left for a short distance of about 10 centimeters and then proceeds upward to join the spider-web like veil on the duodenum—the periduodenitis It is particularly significant that the membrane is limited precisely to the point where the large bowel begins and in fetal life is adherent to the underlying structures This would suggest strongly that the membrane is in some way secondary to embryonic or fetal structural growth Examination of fetuses confirmed this opinion, for 3 of 7 studied showed a fine spider-web beneath the liver which involved the liver, gall bladder, duodenum, and colon This spider-web demonstrated *en miniature* what is found in essential periduodenitis, but there were present in addition fine band-like adhesions which many authors call secondary periduodenitis

The second factor in the etiology of this red membrane is the so-called red stomach I described a syndrome in 1925<sup>2</sup> which closely resembles periduodenitis The patients are usually operated upon under an erroneous diagnosis of peptic ulcer, but at operation there is found the characteristic redness of the pyloric antrum The

<sup>1</sup>Laqua Beitr z klin Chir cxlviii Hft 2

<sup>2</sup>Surg Gynec & Obst 1925 xl 303

# CLINICAL SURGERY

FROM THE CLINIC OF THE CITY HOSPITAL OF THE HAGUE

## PERIDUODENITIS

JAN SCHOLMAKER MD FACS (Hon.) THE HAGUE HOLLAND

LAST year when Clairmont discussed peritoneal adhesions before the German Surgical Society he mentioned periduodenitis but he did not enter into a discussion of its characteristics. Much of his material was supplied him by von Eiselsberg, Kuettnner, Payr, and Schmieden, but none of these surgeons definitely interpreted the pathological significance of this condition, which presents cord like or membranous adhesions between the duodenum, stomach, liver, gall bladder and transverse colon in other words adhesions in the space which the French call *curresfour soushepatique*.

It is evident that these adhesions can be divided into two types. They may be cord like structures or ligaments of varying size binding together the organs mentioned or they may be delicate, thin spider web like veils. The latter type is most commonly found on the duodenum from which it spreads out to the large and small omentum. On rare occasions the adhesions spread to the pylorus but almost never involve the stomach.

In the first group the adhesions are usually secondary to an active or healed inflammation of the gall bladder to ulcer of the stomach or duodenum, or to a previous operation in this region. They may even be considered secondary to appendicitis. The second type of adhesion is called by Duval the 'essential type'. Some surgeons believe that the 'red membrane' present in such cases is the anatomical basis for a definite, classic clinical picture while other surgeons believe that the symptoms are secondary to the stenosing effect of the membrane upon the duodenum. The form described first, the secondary, is well known to all of us but we are more or less certain that it is of relative unimportance.

The adhesions which are found during a cholecystectomy or stomach resection and which may be causative factors in the symptomatology, we always separate knowing full well that they will reform especially if the abdomen is drained, but

we no longer believe that these new adhesions will lead to future complaints. However, I have seen one case in which the symptoms were referred to the site of adhesions whereas the primary etiological focus was far removed.

This happened in a woman 34 years of age who 4 years ago had a left sided pleurisy with effusion probably of tuberculous origin. The gastric symptoms began after the pleurisy had healed. She complained of epigastric pains which were worse at night and which radiated both to the left and right sides. Belching, occasional emesis which once was blood tinged, sour regurgitation and obstipation were also present. Physical examination revealed a small well poised woman. The thorax was negative and the pleurisy apparently completely healed. The epigastrium and gall bladder region were extremely tender to palpation but the remainder of the abdomen was negative. Functional gastric analysis showed normal acidity, the stool was negative to a benzidine examination. X ray examination showed the duodenal bulb always distorted and never completely filled, the gall bladder negative with no calculi present. The X ray diagnosis was duodenal ulcer or periduodenitis.

The patient insisted on operation as she had had symptoms for 4 years which had not been relieved by medical treatment. Dense membranous adhesions found between the liver and parietal peritoneum immediately suggested that this was not a true case of periduodenitis. Similar adhesions and cord like bands were found between the liver and transverse colon which when separated exposed a normal non distended gall bladder containing no calculi. The stomach and duodenum were negative, neither ulcer nor gastritis being found. There were still more adhesions which covered the caecum and appendix. These adhesions were firmer and more irregular than the pericolic membrane frequently found over the caecum and called Jackson's membrane. The appendix was removed because it was thicker than normal. Histological examination revealed an occasional tubercle below serosa of the appendix. The patient recovered from the operation and has remained perfectly well.

In this case it was demonstrated that tuberculosis of the appendix was the primary cause of the adhesions and it is obvious that the symptoms were localized at the site of the adhesions. From this case one may draw the analogy that secondary periduodenitis may lead to symptoms which disappear upon removal of the etiological cause.

intra-abdominal interference is contra-indicated. Although surgery does not in itself accomplish much it is of some little value in that it convinces us of the absence of ulcer and the patient can then be treated more intensively by psychic therapy.

The following history is a typical example of this technique or procedure and is classic for many other patients in my series.

A girl, 29 years of age, was admitted to the hospital in 1926. Abdominal, gastric, and nervous complaints had been present for many years. Appendectomy 8 years ago revealed no pathological changes and gave no relief. In 1926 she had severe pains in the epigastrium, and was convinced that adhesions were responsible for these symptoms. A laparotomy revealed a very red pyloric antrum,

and on the duodenum a membrane which was removed. The gall bladder and the rest of the organs were normal. After operation the patient still complained of moderate distress but psychic therapy could relieve it and the patient was soon in excellent physical and psychic condition.

Three and one half years after the operation she says "I am much better than before the operation. Indirectly, the operation helped me very much. I now know that I am able to overcome my symptoms and find I can actually do this. I have started to work again and am at present in excellent condition despite two relapses which occurred after psychic upsets."

I believe that we will be able to help our patients by just this type of treatment and if we cannot do this ourselves, we must teach either the family physician or a skilled neurologist to do so.

location of this redness is always typical, it covers the entire pyloric antrum and ends medially very abruptly at the junction of the pylorus and body of the stomach (corpus ventriculi). The duodenal edge is not always sharply limited but occasionally extends over beyond the duodenum. When this occurs, the duodenum itself is not red but the veil previously described.

Now in these three conditions—pericolicitis, periduodenitis and red stomach—various clinical and pathological findings are common to all.

The redness, the hyperæmia, is pathological but does not mean inflammation. I have examined histologically every colon with a Jackson's membrane which I have resected and have always found marked capillary engorgement of the capillaries in the serosa, but no leucocytic infiltration or oedema, no new connective tissue formation, and nothing abnormal in the deeper layers of the bowel. And when I resected a red stomach with the mistaken diagnosis that it was ulcerated due to a history of gastric hæmorrhage, the findings were exactly the same as those found in the colon. The mucosa, submucosa and muscularis were absolutely normal but there was marked hyperæmia of the serosa. The large blood vessels as well as the capillaries are dilated and filled with blood. Oedema and infiltration are absent and when the glands on the greater curvature are enlarged they also show only a hyperæmia with out inflammation. There is therefore, no similarity between red stomach and gastritis.

But these three, pericolicitis, periduodenitis, and red stomach have several clinical findings in common. First, the pain is as a rule severe and localized to the hyperæmic area. Further, diet has no effect upon the duration and character of the pain. Rest always affords relief, and finally, psychic insult always aggravates the symptoms.

All my patients were of a nervous type. A few were cured by surgery, but in the majority the symptoms returned—a very significant factor pointing to the nervous basis for this syndrome. I am convinced that we must consider the periduodenal membrane as congenital but that the hyperæmia is definitely associated with the onset of symptoms and that the connection with the nervous system is still to be found. In these cases the vegetative nervous system should play a most important rôle. We are tempted to speak of vagotomies or sympathico tonia, but to surgeons these words have too hypothetical a sound.

The practical question is—what shall we do to relieve a patient with a periduodenitis?

My opinion is that once the correct diagnosis is made surgery is contra indicated and the treat-

ment should consist in rest, suggestive therapy, antinevryne, and diathermy to the epigastrium. As a rule however, this procedure is not practical. The patient usually has been treated for a long time without success by an internist and finally as a last resort is operated upon for fear an ulcer has been overlooked. An ulcer is not found, however, but the periduodenitis is discovered—what then?

The first thing to determine is whether this periduodenitis is essential or secondary. When most of the adhesions are cord like and irregular and when the majority of them extend from the duodenum and liver to the gall bladder instead of to the transverse colon we can be sure that the periduodenitis is secondary and turn our attention to the gall bladder first. In treating these adhesions it is important to remember that Duval has described many such adhesions as congenital and has considered them as ligaments of no pathological significance.

If however, we have to deal with an essential periduodenitis with a veil on the duodenum, one operation is absolutely contra indicated and that is a gastro-enterostomy. If this is done the patient not only is not relieved of the old symptoms but develops new ones, especially the vomiting of bile. The first thing to determine is whether the edge of the membrane is dense and firm enough to constrict and stenose the duodenum. If it does this it should be resected. Taylor, Duval, and Roux believe that its removal is of marked importance.

I know that such a constriction may occur but it is the exception rather than the rule. In 3 cases I removed this constricting band with an excellent result but in 100 cases no stenosis was present. In the non stenosing type of case, the abdomen may be closed without further surgical interference and the patient treated as any other nervous patient, or a duodenal exclusion may be performed.

If pain really comes on immediately after eating and disappears as soon as the stomach is empty, we may conclude that the pain is secondary to the passage of the food through the duodenum. In such a case, the stomach should be separated from the duodenum which is then closed and the stomach is united to the jejunum. In 2 of the 3 cases in which I have done this the results were excellent but in the third patient exactly the same symptoms are present as before operation, all of which is not very encouraging.

Once we are convinced that the nervous element is the predominating factor, and this is true in most of these cases, it is obvious that

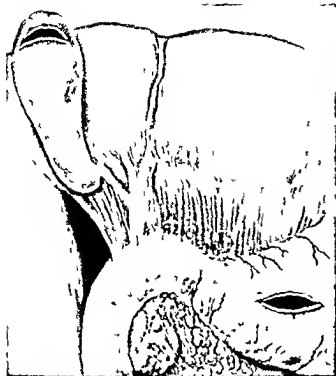


Fig 1 Cholecystogastrostomy Showing the position of the incisions in the stomach and gall bladder. The common bile duct was obstructed by a carcinoma of the head of the pancreas

small, is tied with fine catgut. The deep layers of the rectus sheath and the peritoneum are incised vertically to a sufficient extent, but this incision is at least 2 inches shorter than the superficial wound, which makes it far easier to close. The abdomen is systematically, but rapidly explored for any sign of disease which may have a bearing upon the jaundice, such as carcinoma of the colon, then the liver, gall bladder, and bile ducts are examined with minute care to ascertain the exact cause of the jaundice. In most cases, the gall bladder is enlarged and the common bile duct distended. The duct is carefully palpated for stone, especially in its lower reaches about the ampulla of Vater.

The selection of the most suitable operation is now made after due consideration. Before the actual operation is commenced, the abdominal wall and the neighboring viscera are carefully protected from contamination or injury by moist gauze packs.

**Choledochostomy** In some cases, it is necessary to open the common bile duct in order to make certain if there is or is not a stone in the bile duct. If a stone is found, it is backed whenever possible and removed through an incision made in the supraduodenal part of the duct, but in some cases, when firmly impacted, it has to be removed

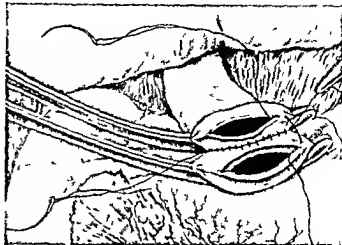


Fig 2 Cholecystogastrostomy Showing the insertion of deep and superficial continuous sutures of fine catgut

by the retroduodenal or transduodenal routes. Occasionally within the common bile duct a small hydatid cyst or debris, a papilloma, or a slough may be found and removed.

**Cholecystogastrostomy** When the head of the pancreas is enlarged, it is palpated with care in the hope of finding a stone in the ampulla or at the duodenal papilla. The harder the pancreas, and the more localized the swelling, the more likely is it to be due to malignant disease. Softer and more diffuse enlargements are commonly due to chronic pancreatitis. Rarely is it wise to remove a piece of the pancreas for microscopic section for this may cause unnecessary danger from bleeding, and does not assure the establishing of the diagnosis. (Fig 1)

When the cause of jaundice is irremovable and the gall bladder is distended with bile, cholecystogastrostomy is indicated. It is far better, easier, and safer to shortcut the gall bladder to the stomach than to the duodenum, jejunum, or colon. Ascending infection of the liver is also less liable to ensue after this operation.

It has been well established by clinical and experimental surgery that the discharge of all the bile into the stomach does not interfere in any way with gastric digestion.

If the gall bladder is very tightly distended, the bile is aspirated, for this makes the anastomosis much easier and safer. Soft curved clamps are placed upon the fundus of the gall bladder and upon the front wall of the stomach 2 inches to the left of the pylorus, so that the passage of food through the latter may not be interfered with (Fig 2). The anastomosis is then made with two continuous fine catgut sutures. As the stoma is apt to contract, it is important

## FROM THE SURGICAL CLINIC, GUY'S HOSPITAL

## OBSTRUCTIVE JAUNDICE

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**J**AUNDICE, due to obstruction of the common bile duct or of the common hepatic duct, is generally defined as obstructive, it has to be carefully differentiated from that due to diseases of the liver and small bile ducts. Its causes are numerous and varied, as may be seen from the following rough but convenient classification: (1) those inside the common bile duct, (2) in the wall of the duct, (3) outside the duct.

*Inside the duct* Here the causes may be stone, blood clot, hydatid, slough, liver fluke, round worm. Of these, stone is infinitely the commonest, but I have removed organized blood clot, hydatid, and a slough which were obstructing the common bile duct. The slough had passed through a dilated cystic duct after cholecystostomy for the relief of acute cholecystitis, it contained a catgut suture.

*In the wall of the duct* There may be stricture, following operation or injury, kinking of the duct, papilloma, adenoma, or carcinoma in common hepatic duct, in common bile duct, or at duodenal papilla.

*Outside the duct* Here there may be enlarged glands, especially malignant glands, carcinoma of the pylorus, any large abdominal tumor, aneurism, pancreatic cyst, hydatid cyst, renal growth, such as hypernephroma, any of which may obstruct one of the main bile ducts.

## INDICATIONS FOR OPERATION

I advise an operation in all cases of obstructive jaundice in which no bile reaches the bowel, and the serum bilirubin remains well above the normal, if the patient is well enough to stand the operation for in spite of all improvements the differential diagnosis is so difficult and uncertain that grave mistakes are frequently made. By accepting too readily the diagnosis of malignancy, we may either miss the opportunity of curing the patient by removing an unsuspected stone, which by no means always causes colic, or of correcting the jaundice with its intolerable itching, by adopting some form of internal or external drainage for the bile. This also prolongs life and makes it far more enjoyable. The risk of the operation is small compared with the great benefits it may confer.

At the best, the patient may be cured by the operation, at the least, he will nearly always be rid of his jaundice with its maddening torture of itching, its anorexia, wasting, and mental depression.

When the gall bladder is enlarged, it is almost certain that the jaundice can be overcome with out the miseries associated with a cutaneous biliary fistula.

## DANGERS AND POSSIBLE COMPLICATIONS

Bleeding used to be the chief danger of operations for jaundice. Fortunately, it can now be almost completely avoided by careful preparation of the patient before the operation, and by ligaturing every bleeding point at the operation.

Suppression of the liver functions is another danger, which may be very largely met by the careful preparation and after care of the patient.

## PREPARATION

Operations for the relief of jaundice are never so urgent as to prevent thorough preparation of the patient and rest in bed for several days on a careful diet. If the blood does not clot in the normal time, 5 cubic centimeters of a 10 per cent solution of calcium chloride are injected intravenously for 3 or 4 days before the operation and until the normal clotting time is restored. Liquids and glucose are freely administered to restore the liver functions and a light diet consisting chiefly of predigested food, such as Benger's, is given to restore the nutrition. The bowels are gently opened and the colon washed out the day before the operation. After the bath, the skin is prepared by painting with tincture of iodine, picric acid solution being avoided on account of the frequent irritability of the skin.

## TECHNIQUE

A long right paramedian incision is made, beginning at the upper end of the epigastric angle and extending a little below the umbilicus. The rectus sheath is opened an inch from the middle line and turned inward, and the rectus muscle is drawn outward. This incision gives the best access to the common bile duct and causes the least bleeding. Every bleeding vessel, however



Fig 5 Lateral choledochoduodenostomy. Flaps of the omentum are carefully sewn over the anastomosis

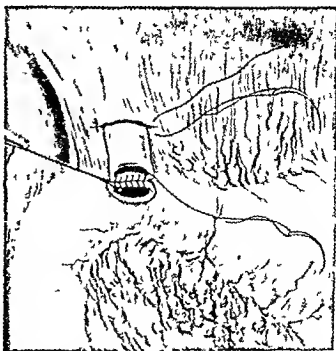


Fig 6 End to side choledochoduodenostomy. A collared rubber tube is inserted to maintain the channel. In addition, flaps of the omentum are sewn over the anastomosis

deep jaundice is associated with cholangitis, fever, and rigors. The ultimate prognosis is often doubtful, for the diagnosis between chronic pancreatitis and malignant disease of the head of the pancreas often remains uncertain at the end of the operation. The patient suffering from chronic pancreatitis generally improves continuously and puts on weight, whereas those afflicted by carcinoma of the head of the pancreas rarely survive more than a year after the operation, but as

already stated, the relief obtained is very great. Subjects of irremovable carcinoma of the common bile duct may survive for 2 or 3 years after the operation. Some degree of ascending infection of the bile ducts probably follows most cholecystogastrotomies, but apart from returning obstruction from stenosis of the stoma, there may be no clinical symptoms of this infection of the liver. Occasionally there may be attacks of jaundice associated with fever.



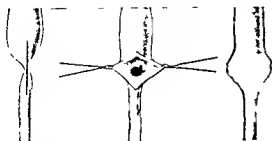


Fig. 3 Operation for stricture of a bile duct. A longitudinal incision through the stricture is converted into a transverse one.

to make it at least an inch in diameter, flaps of the greater and lesser omenta are fixed in front and around the anastomosis.

**Cholecystostomy.** In a few selected cases especially of pancreatitis with cholecystitis and thick walled, contracted gall bladders in very ill patients, cholecystostomy is the operation of choice, and prolonged drainage has often proved successful in overcoming the inflammation of the biliary apparatus and pancreas.

**Restoration of the bile duct.** It is often possible to overcome a fibrous stricture of the bile duct by a plastic operation (Fig. 3) and occasionally the duct may be reconstructed after excision of a malignant stricture (Fig. 4).

**Choledochoduodenostomy.** When the gall bladder is for any reason, not available for the anastomosis, the most convenient part of the common bile duct or common hepatic duct is joined to the duodenum. Here it is better to choose the duodenum because it is so near to the ducts (Fig. 5). Whenever possible, the lateral type of anastomosis is made, but the end to side method often has to be adopted, especially for the hepatic duct. A tube is inserted in the dilated duct, and the anastomosis is carried out by direct suture as shown in Figure 6. Throughout the operation every bleeding point is tied immediately. When the common bile duct has had to be opened for any reason, I always insert a tube to drain it or its close vicinity; this is brought out through a stab wound an inch below the tenth costal cartilage. The paramedian wound is completely closed in layers, continuous No. 2 catgut being used for the peritoneum and deep layer of the rectus sheath, four or five interrupted mattress sutures of strong catgut are used to approximate the anterior layer of the rectus sheath and a continuous suture brings the edges of this sheath accurately together. A continuous suture of fine

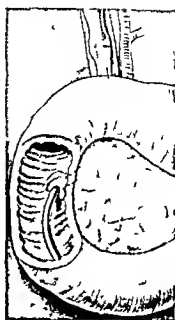


Fig. 4 Anastomosis of the common bile duct with the aid of a long rubber tube projecting into the duodenum. The upper part of the tube is enlarged and has a collar around it to keep it in place.

black linen thread is used to close the cutaneous wound.

#### AFTER TREATMENT

The management of these patients after the operation requires the greatest care. When the jaundice has been long continued, the wound is slow to heal and may break open, if the stitches are prematurely removed, therefore, I leave them in for 10 to 14 days and then hold the edges together with four bands of strapping for another week.

Restoration of the liver functions is encouraged by giving plenty of sugar and glucose by the mouth, or 5 per cent solution of glucose by the rectum or axillæ. In bad cases, glucose is given intravenously with great advantage. Remembering that the secretion of bile and perhaps pancreatic juice may be in abeyance for some days after the operation, Benger's and other pancretized foods are indicated in early days after the operation, but the diet is increased to the normal as soon as possible in these wasted patients.

#### PROGNOSIS

The mortality from the operation of cholecyst gastrostomy is now under 10 per cent and the earlier the operation is performed the lower the mortality. The risk of the operation is much greater in very chronic cases, especially when

<sup>1</sup>I have to thank Messrs J and A Churchill the publishers of *The Operations of Surgery* for their kind permission to use Figures 3 and 4.

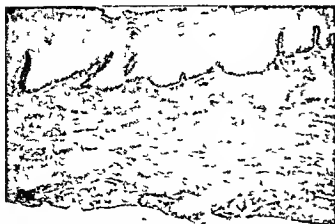


Fig 1 Five days postmenstrual. No evidence of cornification zone. Result of recent desquamation. A bare surface. Vacuolization in basal.



Fig 2 End of first week postmenstrual. Vacuolization in superficial portion of the basal layer.

of the premenstrual phase in the vagina with its characteristic three layers, this effect being obtained after the beginning atrophy had set in due to the castration.

In a previously published series of papers on the morphology of menstrual blood (Geist), I pointed out that vaginal epithelium, either as individual cells or as plaques or cornified masses, was practically always present in the menstrual blood. Then in a subsequent study of smears from the vaginal mucosa, studied in collaboration with Guttmacher, we were led to believe that in the premenstrual and menstrual phases there was a tendency to what we termed "sheet desquamation," that is, a desquamation of vaginal cells not isolated, as is found in all phases, but in sheets or plaques of from five to hundreds of cells. These findings naturally led to a further study of the vaginal desquamation in its relation to the normal uterine and ovarian cycle. A series of 80 cases was studied. The ages of the women varied from 28 to 66 years, 15 were in the menopause, the duration of the menopause was from 1 to 12 years. Of those who were regularly menstruating the ages varied between 28 and 52. All of these women were in good physical condition, except for minor gynecological disturbances. There was no disturbance of the normal menstrual cycle. In other words, both the ovarian and uterine function seemed unimpaired. There were 27 specimens obtained during the so-called postmenstrual period, that is, from the first to tenth day, there were 16 specimens obtained

during the interval from the tenth to twentieth day postmenstrual, and there were 8 obtained during the premenstrual period from the twenty-first to thirtieth day. The 4 other specimens were not utilized or studied, one was from a gravid woman and the 3 other specimens were not in proper condition for examination. The specimens were obtained by removing, during the course of anterior and posterior colporrhaphies, a large oval flap from the anterior and posterior vaginal walls. These flaps were well within the vagina so as to avoid that portion of the mucosa which may have been altered by exposure. In several cases punch specimens were removed at regular weekly intervals during two complete periods in the same woman. The material was fixed in formalin promptly and subjected to the usual histological routine examination.



Fig 3 Second week postmenstrual. Increased thickness of the basal layer. Marked vacuolization. Beginning flattening of superficial cells.

## CYCLICAL CHANGES IN VAGINAL MUCOUS MEMBRANE

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SINCE the discovery by Hirschmann and Adler of the cyclical variations in the uterine mucosa, much progress has been made in our knowledge of the normal physiology of the female generative tract. Novak and Everett demonstrated cyclical changes in the tubal epithelium. These changes were initiated about the second day after the menstrual period. Schroeder and a group of others have shown that the uterine changes are dependent on the ovarian activity. Stockard and Papanicolaou described a cyclical variation in the vaginal epithelium of the rat. It was noted that the tubal changes started approximately on the second day after the menstrual period and that the uterine changes were first noted on the fifth day postmenstrual, while the vaginal changes, as will be shown later, were observed to begin on the seventh day. In other words, the initiation of the impulse for cyclical change descended from the tubes to the vagina in a wave like manner. It was only natural that following the publication of Stockard and Papanicolaou investigators would immediately be led to believe that findings analogous to those in the rodent, could be demonstrated in the human. Dierck published an excellent paper in which he tried to demonstrate that in the human female a definite cycle took place in the vagina. He described the vaginal epithelium at the height of the change as composed of three layers—a basal, a functional, and a cornification zone—and stated that he believed that the vaginal cycle kept pace with the cycle in the uterus and ovary. A gradual increase in thickness of the functional layer with a later development of the cornification zone separating the functional from the basal, and finally a desquamation of the functional at least in part, was noted. Following his article there were many other publications, some supporting his view, others differing wholly or in part. Lindeman has found changes in the vaginal epithelium but not of cyclical nature. He has described similar pictures not only in the functioning vagina but

in menopause and in cases with amenorrhea. Stemshorn likewise differs in his findings from Dierck. Stive agrees with Lindeman and Stemshorn in his findings, and differs with Dierck's interpretation of the cyclical variation in the vaginal mucous membrane. King made a study of the vaginal secretions, but was unable to find a definite cycle approaching that found in the rodent. Pankow finds that the cycle varies even in the individual case. He studied his cases by removing fragments of vaginal mucosa from the same individual during an entire period. He noted the first indication of three layers after the seventh day postmenstrual. He also noted a certain amount of desquamation during the intermenstrual period, as well as during the menstrual period. He believed, however, that there was a definite vaginal cycle. Adler agrees with Dierck, and found definite evidence of three layers most marked in the premenstrual period, and furthermore pointed out the presence of an excessively well developed functional layer in gravidity. In the postpartum period, during lactation, menopause, and before puberty there is no evidence of a functional layer, which facts strengthen the belief in a vaginal cycle. It is reasonable to believe that if the upper muellerian tract presented changes in its epithelium of cyclical nature and dependent on the ovarian hormone, the vagina likewise (the lower portion of the muellerian tract) would undergo a similar variation dependent on the same impulse. Allen was the first to suggest the relation of the ovarian hormone to changes in the human vagina. In castrated apes he was able to produce by means of injections of placental and ovarian hormones a real functional layer in the vagina. Dierck believed that he also demonstrated this relation between ovarian and vaginal changes in the human as Allen had in the ape. In a case of a castrated young woman, Dierck had been able, after injections of more than 9,000 mouse units of folliculin, to produce in this castrate a typical picture



Fig 7 End of third week postmenstrual. Definite line of demarcation between well marked basal layer and superficial flattened functional layer above. This demarcation line in this particular specimen is markedly pigmented.



Fig 8 Beginning fourth week postmenstrual. Definite division into two layers, superficial functional layer ready for desquamation, separated from the basal layer by a definite pigmented intra epithelial cornification zone.

by a cornified mass of epithelial scales separated by a distinct narrow zone from the basal, and apparently ready to desquamate (Figs 7 and 8).

All specimens, it must be emphasized however, do not show this cycle with all the characteristics described. Often certain stages are absent when one would expect their presence from the menstrual history. At the same time it is noted that in different parts of the same specimen the picture may vary. It is difficult with our present method of histological technique to differentiate the phases distinctly at all times. There is no question that overlapping of the various phases and definite variation in the cycle in some individuals, possibly depending on variations in the female sex hormone content, take place. That the cycle exists in the vagina seems unquestionable. It is only necessary to devise some better method of recognition to identify the different phases and their variations. It must be emphasized that cyclical changes cannot be identified in every specimen. In some they seem to be delayed, in others anticipated, while in other groups two phases may be present at the same time in different parts of the same specimen.

### CONCLUSIONS

In conclusion it must be assumed that while there is a wide divergence of opinion, in general it can be stated that the vaginal mucosa undergoes cyclical variations probably dependent on the presence of an ovarian hormone, that at the present time with the usual histological methods available, it is difficult definitely to accord to each picture its proper place in the cycle, and that furthermore, as there are variations in the ovarian and uterine cycle with overlapping and individual differences even in the same patient, so too in the vagina the same variable condition prevails.

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Fig 4 Beginning of the third week postmenstrual Basal layer showing vacuolization Beginning flattening and disappearance of nuclei in the superficial cells Indication of line of separation can be noted (Intra epithelial cornification zone)

The study of this material has demonstrated that the vaginal mucosa undergoes a cyclical variation that keeps pace in a general way with the cycle in the ovary and uterus. In the first week the mucosa consists of one broad layer, the basal layer, with one or two rows of small dark staining cuboidal cells, with central nuclei surmounted by a row of somewhat paler cuboidal cells from two to three layers in thickness. Above this one finds a few additional rows of cells more oval or polyhedral, with round pale nuclei the cell body showing a tendency to vacuolization (Figs 1 and 2) (This vacuolization may represent glycogen). As one progresses to the second week postmenstrual this upper portion of the basal



Fig 6 Third week postmenstrual Differentiation into superficial flattened layer of elongated cells many without nuclei separated from the basal layer by a beginning intra epithelial cornification zone basal layer in many places showing vacuolization



Fig 5 Third week postmenstrual Definite separation into two layers basal layer well marked Vacuolization not so noticeable Very definite superficial flattened layer with poorly staining nuclei Definite line of separation noted

layer becomes thicker due to the increase in the actual cell content. The cells become more vacuolated as they appear in the fixed specimen, the most superficial rows becoming slightly flattened, and the nuclei elongated (Fig 3). In the third week this division into two layers, that is, the basal layer of cuboidal and vacuolated cells and the functional layer of more flattened ones becomes even more marked. The cuboidal cells of the basal layer become more cylindrical and the vacuolation more marked. At the same time the superficial, more flattened layer likewise increases in thickness, and the cells become more elongated and sinuous. It is occasionally noticed that between this flattened layer and the definite basal layer a small zone two or three cells in thickness becomes condensed, somewhat hyalinized, occasionally pigmented, and seems to separate the two main layers into discrete entities (Figs 4 and 5). In the fourth week, that is, the premenstrual, this picture becomes more marked, and we have three distinct zones: a basal with cylindrical cells, the upper rows of which show slight vacuolization, a condensation zone termed by Dierck an intra epithelial cornification zone, and a functional layer made up of many rows of flattened elongated cells with spindle shaped nuclei or with no nuclei. In this zone also one occasionally finds vacuolization (Fig 6). At times in this period or even in the third week the upper zone (the most superficial one) is represented



Fig 1 Impression of the head without aid of an assistant

If impression fails with the aid of an assistant a trial is made under a short surgical degree of anaesthesia

With the use of the method in several thousand cases by internes in the prenatal clinic and in the wards at Cook County Hospital, there has never been observed bad effects of any kind whatsoever to mother or babe

Three conditions in pregnancy are known to prevent impression of the head when no bony disproportion exists. These are incomplete development of the lower uterine segment, excess of liquor amni, and lack of co-operation on the part of the patient. Further experience will no doubt reveal others which have not yet been determined. The best results are obtained the nearer to term the examination is made. The lower uterine segment reaches its highest point of development in pregnancy at term, this process is indicated by the progressive shortening and



Fig 2 Impression of the head with aid of an assistant

softening of the cervix. The impression is tried at each prenatal visit in the last month of pregnancy and final judgment can be made in most cases before term. Excess of liquor amni prevents impression for mechanical reasons and must be given consideration in cases in which the head cannot be made to enter. Oversensitive patients may require anaesthesia, and the muscular relaxation is an aid in some doubtful cases in which voluntary resistance is not apparent. Not more than 4 or 5 cases in 100 require anaesthesia.

As each patient enters labor she is placed in one of two classes. In approximately 95 per cent it is known that the head will enter the pelvis and no bony obstruction will be expected. The 5 per cent remaining are those patients classed as having doubtful mechanisms and are given careful investigation. These patients are studied



Fig 3 Station of the head before impression, above the spines



Fig 4 Station of head during impression, below spines. Patient at term not in labor. Bag of water not ruptured

DIAGNOSIS OF CONTRACTED PELVIS BY IMPRESSION METHOD<sup>1</sup>

DAVID S. HILLIS, M.D. F.A.C.S. CHICAGO

THE determination of the relative size of the fetal head and the mother's pelvis is one of the difficult problems of obstetrics. Much attention has been given to the study of the various types and sizes of contracted pelvis, but, as Williams states, despite the existence of numerous methods devised for accurately determining the size of the head we are still without one that is thoroughly satisfactory. Since the head varies as much in size as does the pelvis, the reason for the difficulty in making this diagnosis is obvious. A successful method to determine this relationship must include a consideration of the size of the head as well as the capacity of the pelvis.

Perhaps the most rational method of making this measurement has been suggested by P. Mueller and modified by Monroe Kerr. This method consists in making pressure on the head, through the abdominal wall, with one hand above the symphysis to determine how far the head can be pressed into the pelvis and to decide whether or not it is meeting with bony resistance or is stopped by soft tissue. Monroe Kerr suggested the use of two hands above the symphysis and an assistant to determine the result of the impression. This method is not generally used because it is technically difficult and must be done under anæsthesia.

A modification of the Mueller maneuver is proposed. It is practically painless and requires no skill beyond that which may be acquired by the doctor in general practice. It is a diagnostic procedure which makes it possible at or before labor to separate all cases into classes: those in which it is known that the head will pass the inlet and those in which the mechanism is doubtful or impossible. It is not recommended as a substitute for the usual diagnostic methods but should be used in addition to them.

The application of this method presupposes a knowledge and use of the following facts. The important diameters of the head and the pelvis are the biparietal diameter and the true conjugate respectively. The successful passage of the head through the inlet depends upon the relative sizes of these two diameters. When the biparietal diameter has passed the true conjugate, bony resistance at the inlet has been overcome. When the lowest bony part of a moderately molded or unmolded head has reached a line drawn between

the tips of the spines of the ischium, the biparietal diameter is passing the true conjugate. Allowance must be made for caput succedaneum and thickness of cervix or lower uterine segment in front of the head. If a head lies lower than this level or can be impressed below this point, it is positive evidence that no bony disproportion at the inlet exists.

The greatest number of serious pelvic contractions are found at the inlet. The cases in which the moderately molded or unmolded head can be impressed below or is found to lie below the ischial spines will rarely be found to offer impassable bony obstruction at the outlet.

With the use of this method it has been shown that the widely prevalent idea that the head at term cannot be pushed downward any appreciable degree with the cervix undilated and the bag of waters unruptured is untrue. In approximately 90 to 95 per cent of all cephalic presentations at term, the lowest part of the head can be impressed to or below a line drawn between the tips of the spines of the ischium. This number, of course, includes those cases in which the head already lies at such a level.

With the patient in the lithotomy position on a table, not too high, the examining finger in the rectum locates the tips of the ischial spines and notes the relation of the lowest part of the baby's skull to a line drawn between them. The hand on the outside is placed above the breech of the baby and is sunk as deeply as possible toward the mother's spine, the forearm parallel to the long axis of the mother. Pressure is then made on the breech toward the inlet and the descent of the head noted with reference to the interspinous line, allowance being made for the thickness of the lower uterine segment, the cervix or caput succedaneum if present. To avoid traumatism and pain the pressure is begun gradually and after the maximum is reached is slowly released.

If the head cannot be impressed to the spines, an assistant places the palm of one hand flatly over the middle of the baby's back to prevent flexion and the fingers of the other hand placed palmar surface downward above the head over the symphysis presses the head downward and backward in the axis of the inlet while the examiner makes pressure on the breech and notes descent with the internal finger.

<sup>1</sup>From the Department of Obstetrics and Gynecology, Northwestern University Medical School.

Their advantages are—they are cheap, they can be procured almost in any town hardware store on a few minutes' notice, they can be made in advance out of rustless steel if desired. The pin once inserted through a bone for skeletal traction, remains quite firm, it does not turn or rotate in the wound, it will not slip or pull out, it makes a uniform pull on the bone at a right angle to the long axis of the limb, and it is very dependable especially for embedding in plaster of Paris.

The indications for the use of embedded skeletal traction by means of the Steinmann pin are varied. Primarily it is useful for traction on the leg.

In fractures of both bones of the leg there is difficulty in obtaining lost length either because of the heavy musculature, muscle spasm, or the delay in treatment with consequent swelling. The physician often finds that the short distal segment of the limb is hard to hold after the bones are pulled out to proper length so that a retention splint may be applied. A fracture table helps in many of these fractures, but one may fear pressure about the malleoli from the straps or bandages which hold the foot to the table foot piece. A pin inserted through the calcaneus will afford proper points on which the traction may be fastened and drawn up tightly to effect fragment reduction without running the risk of constricting pressure of the soft parts of foot or ankle. When a reduction is thus satisfactorily accomplished, plaster of Paris can be applied from upper thigh to toes incorporating the pin in the plaster. After the limb is released from the traction on the table the relationship of fragments remains as it was and the reduction is held without fear of plaster pressure on the soft parts, the pressure or pull being transmitted to the distal part of the leg through the pin by its skeletal grip.

This same aid may be useful in fractures of the femur at any level—even the neck—because the pin aids greatly in the traction down the long axis of the leg or in holding the rotation needed for inversion of the foot. Especially is embedded skeletal traction valuable in open fractures, debrided, and then encased in plaster of Paris.

Two other types of fracture in the leg are greatly benefited in treatment by embedded skeletal traction. One is fracture of the leg treated by open operation where no strongly supporting internal splint is used. By this is meant particularly old fractures of the leg with malunion or non union, in which the bone surfaces are freshened, cleaned, and apposed, and no internal splint such as a metal plate or graft of bone is used to

steady and hold the fragments together. If much tissue has been cut away from the tibia, the operator finds that he has to shorten the fibula to get an apposition for the tibia, that is he has to push up on the foot to bring bone surfaces together. An intramedullary splint of bone may be used as a guide to hold fragments in proper relationship, but it will not hold them together, and if there is no desire to use an internal fixation splint, which operation is rapidly going out of use, some means must be had to hold bone fragments in apposition.

The embedded skeletal traction accomplishes this admirably, used as a means of pushing the foot up and holding the distal bone fragments against the proximal fragments until the wound is closed and the plaster dressing is applied. By means of this security the patient may then be taken off the fracture table and bony apposition found to be satisfactory.

Another type of fracture often difficult to reduce and hold while the external splint is applied is lipping fracture of the tibia with or without dislocation at the ankle. Particularly in instances of posterior lip fracture of the tibia is it difficult to drag down the posterior lip of the tibia, to hold the ankle in reduction, to hold the leg flexed at the knee to relax the calf muscles while a suitable plaster dressing is applied. By means of embedded skeletal traction through the calcaneus these things can be easily accomplished and the patient saved the necessity of an open operation to attempt to fasten down the elevated posterior joint fragment of the tibia.

The technique of the insertion of the Steinmann nail needs no explanation here. It is done under strict aseptic precaution, the nail is driven through the selected bone as a nail would be through a plank, by means of a suitable hammer, a carpenter's instrument, not a toy hammer. Three sites are possible, the supracondylar area of the femur, the anterior surface of the tibia, and the calcaneus. The rules and technique of insertion have been given in detail by the writer elsewhere.

After the skeletal traction is applied, the skin puncture wounds made by the nail are covered with several layers of dry gauze dressing. If it is wished, over the dressings may be placed impervious waxed paper or cut out pieces of old sterilized rubber glove to keep the potentially septic moisture of the plaster of Paris from contaminating the wounds. Sheet wadding is applied over the leg, the position of which has been determined by the procedure undertaken to reduce a recent fracture by traction or to hold an old fracture in



with special reference to amount of overriding of head, diagonal conjugate diameter, estimated size of baby, and measurements and type of pelvis. X ray measurements of pelvis and head may be made if facilities permit. After labor has begun the method is used from time to time and a decision as to the necessity for abdominal delivery can usually be made before the time limit of safety for a cesarean section has been passed. All patients in whom the head cannot be impressed below the spines at the beginning of labor should be managed with a view to possible abdominal delivery.

If, after a fairly early rupture of the bag of

waters in labor, the head cannot be impressed to or below the spines a cesarean section may be done at once and in our opinion with proper facilities at hand is justified.

Experience with this simple procedure has led us to believe that it is worthy of further development by general use to the end that practical working rules may be laid down to solve the important question of the relative size of the baby's head and the mother's pelvis.

**NOTE**—This procedure was referred to and described in a paper by D. S. H. "The Obstetrical Forceps Operation" published in *Virginia Medical Monthly*, December 1915.

## PLASTER EMBEDDED SKELETAL TRACTION

### USE IN TREATMENT OF FRACTURES

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**F**OR general use two types of skeletal traction are universally feasible. One type is the caliper—a modification of Ransohoff's ice tongs, built on the same mechanical principle and found ready for use in many hospitals. A few of these calipers have certain structural defects which limit their use. In some the sharp points which penetrate the skin and are buried in the bone for the skeletal grip are too broad in diameter, too short in length and insecurely fastened to the handle portion. In certain types these points are detachable and they consequently become loose or unscrew easily, leading to insecurity. The axis at which they are attached to the handle is often mechanically incorrect. When they are attached at a right angle and enter the bone through the soft parts their skeletal grip is weak; they easily pull out, they bring all traction pressure to bear on the anterior surface of the point inserted into the bone. The axis of the skeletal grip of the caliper on the bone should be at an angle of 45 degrees to the long axis of the bone. The pull is then largely against the inserted point of the caliper in the long axis of the bone, and the harder the pull on the traction, the deeper the penetration, and the greater the security of the caliper point.

Any caliper, however, may pull out of the wound in the bone and soft parts. During movements of the patient, involuntary twitchings or spasm dur-

ing sleep or by intention the caliper may be jerked out of its set position. It is also true that the inserted skeletal grip point is subject to some rotatory movement in the skin and soft parts as the traction is steady in one axis and the leg is free to move in others. Such movement in the soft part wound invites irritation, the introduction of skin bacteria into the puncture wound, and may convey infection into the bone locally. Calipers have other mechanical restrictions—they may be too small to embrace the limb of a patient, the opening cannot be enlarged beyond a certain width. One additional factor mitigates against their use in some hospitals, namely their cost. To keep on hand a set of six or more calls for considerable investment. The technique of insertion is not easy, it cannot be well done even by some surgeons, and the casual operator often finds great difficulty in setting the skeletal grip with proper satisfaction.

A second type of skeletal traction in common use is the Steinmann pin. Just why this pin should be offered on the surgical instrument market as a bisected steel pin, sharpened at both ends, is not understood. A suitable piece of steel drill rod 7 to 10 inches long sharpened bluntly to a point like a lead pencil by turning down on an emery wheel will give a cheap source of supply. Pins of varying sizes can be thus made, to be kept on hand and to be used over again if desired.

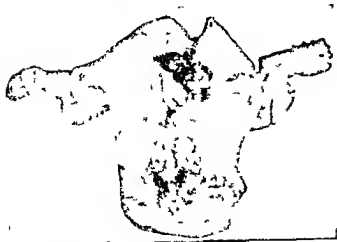


Fig 1 The uterus, removed at operation, its wall infiltrated with adenoacanthomatous tissue



Fig 2 The mediastinal tumor, which proved on microscopic examination to be an adenoacanthoma

shows a few small injected blood vessels but no adhesions. The lumen is patent except at the distal portion, which is obliterated by fibrous tissue. Fecal material is present. The mucosa is thin, the wall fibrotic.

**Microscopic pathology** "Sections show adenocarcinoma of a type common to tumors of the body of the uterus. The tumor acini vary in size, some being small while others are very large. They are lined with single or multiple layers of cells which in the larger spaces often show a tendency to form small secondary acini. In certain areas the cells have lost their glandular structure and are arranged in solid masses. Mitotic figures are numerous. The stroma is relatively scanty, consisting generally of delicate strands of vascular fibrous tissue. It is infiltrated with many inflammatory cells, small round cells predominating. Sections through the uterine wall show that the tumor extends rather deeply into the muscle. The appendix shows a chronic productive inflammation, which in the distal part has resulted in extreme narrowing of the lumen and disappearance of the mucous membrane and lymph follicles."

**Postoperative history** The patient progressed normally during the first week after the operation. It was then noticed that the vaginal discharge had a marked urinary odor, and the patient stated that there was a marked dribbling of water from the vagina. It was evident that a vesicovaginal fistula existed. Upon discharge from the hospital the patient was instructed to report at stated intervals. During the summer she was again admitted to the hospital and treated for left sided pyelitis. As the vesicovaginal fistula persisted, closure was decided upon in August 1927. The operation consisted in denudation of the wall of the fistula and the sewing up separately of the bladder mucosa, connective tissue and vaginal mucosa, plain catgut being used except for the vaginal mucosa which was sutured with chromatic catgut. A permanent catheter was inserted.

The pathologist's report stated that the tissue which consisted of two small masses the largest of which was 4 centimeters in length and 1 centimeter in diameter, showed chronic inflammatory reaction.

Microscopically, the fragments showed a dense and relatively noncellular connective tissue diffusely infiltrated with round cells. There was no evidence of malignancy or of tuberculosis. Epithelial elements were not demonstrable in the sections, and a sinus tract was not found.

<sup>1</sup>Re examination of the tumor after removal of the adenoacanthoma of the mediastinum showed it to contain adenoacanthomatous tissue.

Seven months after the operation the patient had gained about 15 pounds. The pelvis was normal, there being no indication of any recurrence of the carcinoma. There was scarcely any leakage between the bladder and vagina, and later the fistula closed entirely.

The patient reported at stated intervals, and her condition remained perfectly normal until September, 1929, when she complained of pain in the stomach region, loss of appetite, and some difficulty in swallowing. Examination at this time was negative. The symptoms persisted however, and in December, 1929, she stated that with care she had been able to eat small morsels of meat until November, since then only soft food would pass down. Her weight had decreased from 105 pounds in August to 90 pounds. She gave no history of lung trouble, did not cough, and had no pain in the chest, occasionally she felt her heart pound slightly.



Fig 3 (left) Roentgenogram of chest, showing metastasis in mediastinum, more on right side than on left

Fig 4 Roentgenogram of chest 2 weeks after removal of mediastinal metastasis, showing adhesions around lower part of esophagus

apposition by open operation. If open operation or traction is to be used with the help of a fracture table, the insertion of the nail is the first step. After the nail is inserted the foot is bound to the table foot piece, the projecting ends of the nail being used as points of attachment, thus making the foot of the patient and with it the distal segment of the leg beyond the fracture level fixed in such a way that their position in any axis is under mechanical control.

When the position after open operation, traction, or push is satisfactory, is judged by direct

vision or X ray, the plaster of Paris dressing is applied in the usual manner, the nail is disregarded except to be sure it is well buttressed with plaster. After the plaster dressing has hardened, the leg can safely be taken from the table without fear of disruption of fragments or soft part pressure.

When the bone has healed the plaster dressing is cut open, the unpacking around the nail is carefully done, and the nail is extracted under aseptic precautions. The resulting wound heals kindly and promptly.

## ADENOACANTHOMA OF THE UTERUS WITH METASTASIS TO THE POSTERIOR MEDIASTINUM AND LUNGS

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THE case here recorded is of interest for two reasons first, because all writers on the subject agree that adenoacanthoma of the uterus is a rarity, and, second, because a fairly thorough search of the literature has failed to reveal a case of this type of malignancy in which metastasis to the mediastinum and lung has occurred although the tendency of all types of adenocarcinoma to metastasize is well known.

The case seems, therefore, to be unique.

### CASE REPORT

Mrs. C. T., aged 42 years, first reported in May, 1927. She stated that she had had one confinement 18 years ago at which time there were lacerations which had been repaired. About 15 years ago she had a spontaneous abortion and curettage. Menstruation had always been regular until 2 months ago, since then it had been prolonged with spotting at intervals. She complained of "bearing down sensation in the back" and also in the abdomen. She had lost considerable weight during the past year. A physician who had examined her 9 months previously told her that her uterus was slightly enlarged.

The general examination showed the patient to be very thin. The abdominal examination was negative. The abdominal walls were strong and there was no tenderness over McBurney's point.

The vulva was normal, the vagina admitted two fingers. The cervix was markedly enlarged, elongated and extremely hard; it pointed straight back to the hollow of the sacrum. The outer surface of the portio and cervix was normal in appearance. The body of the uterus was very hard, slightly enlarged, anteflexed and movable. The adnexa were normal. A sound could be passed no further than the internal os, where it encountered an obstruction.

The tentative diagnosis was carcinoma of the uterus.

The patient was then examined under narcosis and a probatory curettage was done and a large amount of apparently adenocarcinomatous tissue was removed. Complete hysterectomy was therefore, decided upon.

**Operation.** A total hysterectomy was performed in May, 1927. Through a midline incision above the symphysis the uterus and both adnexa were removed in the usual manner. The uterine cavity was not entered during the operative procedure. The cervix was found in close proximity and adherent to the bladder and was freed with difficulty, suggesting invading carcinoma. The appendix being about 4 inches in length was then removed; the stump was cauterized but not inverted.

Upon opening the uterus its entire wall to a depth of 0.5 centimeter from the mucous membrane was found to be invaded with carcinomatous tissue; every portion from the fundus to the internal os being involved.

**Pathological report.** Gross appearance. The specimen in formalin consists of (1) several irregular pieces of material designated uterine curettings and (2) a uterus in the fresh state with cervix already sectioned and with tubes and ovaries attached. The uterus measures 12 centimeters in length and about 7 centimeters in width. The outer surface is smooth except where torn by operative instruments. The lips of the cervix are slightly beaded but soft. On section the uterine wall measures 2.5 centimeters in thickness. The entire uterine cavity is filled with bloody, necrotic material which completely hides the endometrium. The latter is eroded in many places especially near the cervical portion where the uterine wall is also involved. The tubes are alike on both sides being slightly injected and measuring approximately 10 centimeters in length. The fimbriated ends are patent. The ovaries are yellow in color convoluted and measure 3.5 centimeters by 1 centimeter. They are firm in consistency. The third specimen consists of an appendix measuring 6 centimeters by 4 centimeters. The serosa

made an uneventful recovery from the operation and is now receiving prophylactic X ray treatment

March 27, 1930, vaginal examination showed there was no local recurrence. Patient still had difficulty in swallowing apparently due to adhesions around the esophagus.

*Pathologist's report Gross appearance* "The specimen, received in the fresh state, is designated 'mediastinal tumor and adjacent diaphragm.' It consists of two pieces of tissue. The larger piece measures 9 by 5 centimeters the smaller, 7 by 3 by 0.6 centimeters. The smaller specimen fits tightly against one margin of the larger specimen. The large specimen is not encapsulated, but is fairly well circumscribed. The surfaces are ragged and irregular. On section the tumor is seen to be composed of a thin, interlacing stroma in which is soft, friable, almost gelatinous tissue. The tumor is very vascular and several areas of diffuse hemorrhage are seen in its substance. The small specimen from the diaphragm is composed of a pinkish gray, soft, friable tissue, with a somewhat granular surface, which in section is of a more fibrous nature than the large specimen."

*Microscopic pathology* "Sections of the peripheral portions of the tumor show a carcinoma composed for the most part, of columns and islands of pavement epithelium supported by delicate strands of fibrous tissue bearing this with blood vessels of small calibre. The greater part of the epithelium shows neither intercellular bridges nor epithelial pearls. The constituent cells are usually small and hyperchromatic, though there are areas composed of larger cells which stain less deeply with hematoxylin. Mitotic figures are fairly numerous. In many areas, there are small masses or nests of differentiated squamous epithelium often showing central cornification or pearl formation. Included in the tumor are a few small spaces bordered by cylindrical epithelium or more or less well defined glandular acini. Near one surface of the tumor there are small islands of pulmonary tissue, and attached to the surface is a small quantity of atelectatic lung tissue. Toward the deepest part, the tumor shows extensive necrosis, sometimes with replacement fibrosis. In the newly formed fibrous tissue are a number of cholesterol crystal spaces often bordered by giant cells."

*Diagnosis* Adenocarcinoma of the lung and posterior mediastinum secondary to adenocarcinoma of the uterus

#### REVIEW OF LITERATURE

Adenocarcinoma of the uterus is classified by Ewing, who followed the plan of E. Kaufmann, into four groups (1) malignant adenoma, (2) papillary adenocarcinoma, (3) alveolar carcinoma, (4) squamous carcinoma.

Of these, malignant adenoma is the most frequent form. It presents cords of pavement epithelium in which alveoli, pearls, spine cells, and hornification are not demonstrable. It is thought to have its origin in the endometrial glands, while papillary adenocarcinoma is believed to arise from the superficial endometrial epithelium.

Alveolar carcinoma is rare and is formed of small solid masses of cells forming occasional small alveoli. These, according to Ewing, are more malignant than adenomata.

He writes "Squamous cells may form a prominent element in adenocarcinoma of the corpus and in rare cases they predominate over the

glandular structure and produce a true adenocarcinoma. While in many cases neither spine cells nor keratohyaline granules are demonstrable, in others both these criteria of true squamous cell epithelium are present, and pearl formation is added. The squamous cells usually appear in foci in the alveolar lining, where the sharp transformation of cylindrical into flat cells may be followed. Such cell foci usually fail to show hornification. Rarely, all the adult characters of true acanthoma are observed."

Ewing (1928) states that at least three primary adenocarcinomata of the corpus, all in elderly women, have been described (Gehhard, Kaufman, Flaischlen). Meigs (1922) found that at the Free Hospital for Women, Brookline, Massachusetts, since 1903, 44 cases of adenocarcinoma of the uterus have been encountered in 9,566 operations, and of these one was of the squamous celled type.

Zeller (1885) was the first of modern authors to give particular attention to squamous celled adenocarcinoma. He claimed to have found 63 cases in the literature in which this type of growth involved the uterus, the cervix, or both. However, many of the descriptions in these early cases are inadequate, thus leaving the true type of the growth in doubt. It is highly probable that a number of these cases were not true acanthomata in view of the fact that so few cases of this kind have been described in the more recent literature. Zeller called the condition "psoriasis uterina" and, indeed, in the early reports the term adenocarcinoma is not employed.

There soon followed reports by Piering (1887), Benckiser (1891), Gebhard (1892), 2 cases, Pfannenstiel (1893), Flaischlen (1895), Hofmeier (1895), 2 cases, and Gellhorn (1897).

Gehhard's case, referred to by Ewing, occurred in a woman, aged 66 years. He states that the growth showed both epithelial pearls and cancrroids. A complete hysterectomy was performed and the patient recovered.

Flaischlen reported a typical case, reviewed the literature, and classified squamous celled tumors of the uterus into three categories, largely dependent upon the location.

In 1901, Emmanuel collected 9 cases apparently meeting the requirements of true acanthoma, to which he added a case of his own. In 1907, Schauenstein listed 27 cases culled from the literature, and described 3 additional cases which came under his observation, one of these being a primary squamous celled adenocarcinoma of the cervix. In the second, cancrroids were found in a growth in the corpus uteri, while, in the third, the cervix and the entire corpus were



Fig 5 Uterine tumor showing prevalence of adenocarcinomatous glands

Examination revealed dullness low down on the posterior aspect of the chest especially on the right side on the left side there was dullness only close to the spine. Over the dull area the breath sounds were faint above that area voice transmission was increased. An occasional rale could be heard on either side. Roentgenological examination of the gastro intestinal tract was determined upon and earned out on December 26 1923.

**X-ray examination.** Fluoroscopic as well as roentgenographic examination revealed a smooth, round circumscribed mass in the right chest appearing just above the right diaphragm and extending beyond the right border of the heart. It apparently arose in the posterior mediastinum. The tumor caused distinct pressure on the esophagus and occasioned considerable obstruction. Above the point of constriction the esophagus was somewhat dilated.

The stomach was stonic and markedly ptoed the greater curvature being about 70 centimeters below the left iliac crest. There was no roentgen evidence of an organic lesion of the stomach. In the descending limb of the duodenum however a clearly defined diverticulum was observed. This saccululation was suspected of causing a degree of obstruction as there was a large 6 hour and a small 24 hour gastric residue.



Fig 6 Mediastinal tumor showing prevalence of squamous cell carcinoma (low power)

The colon was ptoed and quite spastic.

**Conclusion.** The mass was first thought to be a dermoid cyst. When the clinical findings were revealed however the great probability of a metastatic tumor was the final interpretation of the shadows.

**Operation.** The patient was operated upon on January 30 1930 for the supposed dermoid cyst of the mediastinum. She was placed on her left side leaning slightly forward with the right arm extended over the head. A posterolateral incision was made through the eighth interspace from the angle of the rib to the midaxillary line, and then extended from its mesial and downward corresponding to the eighth ninth and tenth ribs. The incision was carried to the pleura but not through it, as it was intended to do most of the work extrapleurally. The parietal pleura was separated from the eighth and ninth ribs well forward to beyond the anterior end of the incision then it was separated backward toward the mediastinum and downward to the diaphragm. In the course of this procedure the eighth ninth and tenth ribs were cut about at their angles as the sites of the proposed cuts were freed from the parietal pleura. It soon became apparent that the mass was not a mediastinal tumor but a tumor of the lung which had become firmly attached to all its surroundings the firmest attachments being to the diaphragm and to the vertebrae. The dissection was nevertheless continued extrapleurally because this gave a better guarantee of remaining outside the involved areas and because it was evident that a thin slice of the lung would have to be removed with the tumor and that the raw surface of the lung could be best dealt with after the tumor was excised. There was some spitting from the cut surface of the lung which was caught and later closed by a continuous catgut suture. The pleura was then sutured wherever possible but this could be done only partially because portions of it had to be sacrificed in the removal. The lung was inflated and the wound closed without drainage. No chromic gut sutures being used around the eighth and ninth ribs chromic catgut for the muscles and silk for the skin.

After the patient was returned to her room she was given a blood transfusion of 500 cubic centimeters. She



Fig 7 Same as Figure 6 (high power)

involved the endometrium and entirely filled the uterine cavity. There was round celled infiltration with fibrous cords. The flat epithelial layers were irregular and disorderly and often dipped into the musculature. There were areas of changing cylindrical cells in disorderly arrangement, with highly staining nuclei, showing degeneration and vacuolization.

A case of this kind has also been reported by Babes and Paulzo (1926), who call attention to several additional cases in the literature (Limbeck, Kleinhaus, Lehman, Stein). Limbeck's case showed both adenocarcinoma and squamous cell areas with epithelial pearls, and he assumed a double origin for the two types of growth. The case described by Kleinhaus showed involvement of the entire uterine cavity. In certain places a transformation of glandular epithelium into pavement epithelium could be observed, and in places the growth appeared as solid carcinoma. In Lehman's case the growth showed in some places the characteristics of adenocarcinoma and in other places pavement epithelium. In Stein's case there were two distinct carcinomata, and he holds that the cylindrical cells at the base of the growth become stratified and then this epithelium develops squamous carcinoma.

The case described by Babes and Paulzo was unusual in that the patient was only 29 years old, whereas all the other cases seem to have been in elderly women, at least over 50 years of age, with the exception of one case, a woman of 42 years (Meyer). In this instance the growth consisted of solid carcinoma and adenoma, and in places the cylindrical epithelium was replaced by squamous epithelium. These authors think that the squamous carcinoma developed from the stratified epithelium in the cervix, but concede that the origin is problematical.

It is evident from the foregoing review of the literature that an estimation of the exact number of cases of true adenoacanthoma of the uterus is rather difficult, inasmuch as all the characteristics of this type of growth have not always been found. A considerable number of writers have not mentioned pearl formation, and it is quite possible that in some instances this characteristic has been overlooked. The review, however, leaves no doubt that in our case all the requisites of true adenoacanthoma are fulfilled.

In the cases thus far reported no late post-operative history has been recorded and no mention whatever is made of metastasis to the mediastinum or the lung. This is not surprising, for it is well known that malignant growths of the mediastinum are exceedingly infrequent,

tumors in this locality being usually dermoid cysts.

Martini (1914) was able to collect a series of 14 mediastinal tumors, of which 3 were syphilitic, 2 tuberculous, 3 lymphosarcomata, 2 sarcomata, 1 carcinoma, 1 thymus, 1 retrosternal thyroid, and 1 was undiagnosed. Curtis Burnham, writing in 1917, stated that up to that time no surgical cure of a malignant tumor of the mediastinum had been reported, though several cures by means of the X-ray had been claimed.

In 1920, Mix stated that mediastinal tumors are usually secondary to carcinomata of the breast and lung, but occasionally they are derived from tumors of the bones, gall bladder, and stomach.

A very satisfactory classification of tumors of the chest and thorax has been worked out by George H. Heuer (1929). He writes "Of tumors in the chest, and particularly in the mediastinum, there are relatively few. They may be classified as (1) dermoid cysts, which arise near the hilum of the mediastinum, do not affect the trachea, and show in the X-ray plates as clean cut shadows, (2) other cysts such as echinococcus, which are very rare, (3) connective tissue tumors, lipomata, fibromata, chondromata, etc., (4) malignant tumors of which there really are but a few, lymphoblastoma, sarcoma, carcinoma."

Heuer spent 2 years collecting mediastinal tumors which have been reported in the literature, and states that primary carcinoma in this region of the body is much more infrequent than the literature would lead one to suppose. Between 1896 and 1901, Lorish found only 2 cases reported, and between 1901 and 1907 Christian found 1 case.

Acanthoma of the lung, on the other hand, seems not to be such an unusual condition, and is only incidentally of interest in connection with our case, in which it was apparently an extension of the mediastinal tumor. Ewing, writing of tumors of the lungs, states that "in many cases squamous epithelium is mingled with cuboidal and cylindrical cells, as in Kretschmer's case. Wolf (1895) found 8 acanthomata and 7 cylindrical celled tumors among 15 of bronchial origin. Ernst describes a papillary tumor of the lungs which contained hornifying squamous epithelium. Tumors of the lung arise from the bronchial mucosa, the bronchial glands, and the alveolar epithelium. Froelich found extensive bronchial pachydermia with squamous cell cancer. It is especially about tuberculous centers that squamous alterations are observed, and in these situations squamous cell cancer is most frequent."

involved in a typical adenoacanthoma. Cases not already listed to which he refers are those of Opitz (1890), Hirschmann (1903), and Kraus (1905). In these cases both the cervix and the corpus were involved.

Additional cases were reported by Sitzenfrey (1907), Kaufmann (1911), Buttner (1911), Schottlaender and Kermauner (1912). The last named authors published a monograph on malignant tumors of the cervix and uterus, in which they describe a case of squamous celled adenocarcinoma which involved both the cervix and uterus.

The chief interest and discussion concerning this type of malignancy centered in the origin. The situation is summarized briefly by Fung as follows: "They arise in the portio, the cervical canal, or in the endometrium, and their histogenesis has formed the topic of much discussion. It is now rather apparent that such structures do not, as a rule, signify a multicentric origin from cylindrical and squamous cells, and do not require an original heterotopia of squamous cells, but that metaplasia of cylindrical tumor cells into squamous is a frequent characteristic of uterine growths as of some other processes in the endometrium. Hirschmann has shown that the metaplasia is complete, producing spine cells and keratohyalin. On the other hand, Ifruser (1913) reports a case of adenocarcinoma of the cervix with a separate acanthoma of the portio, showing that with multicentric origin tumors may remain separate. Finally, in several cases the histological study strongly suggested that the adenocarcinoid developed from a double origin and not through metaplasia (Hofmeier, Buttner, Sitzenfrey). In chronic erosion I have observed rarely acanthoma arising from the squamous lining, and precancerous changes in the neighboring group of cervical glands. It thus appears that a variable histogenesis may be assumed for this type of growth.

The case described by Kaufmann, to which Ewing refers as a true acanthoma, was a combination of superficial acanthoma with adenocarcinoma, and he held that this implied a double origin from previously altered superficial lining cells and from gland cells. This same case was studied by Eckhardt, who came to an entirely different conclusion, namely, that both types of growth were of the same origin—the cylindrical epithelium of the uterine glands.

During the period of time which we have reviewed, the only true case of adenoacanthoma recorded in this country seems to be that of Noble, published in the *Transactions of the Gynecological Section of the College of Physicians of Philadelphia*, in 1903. Ilirst mentions still

another case reported by Batcheler. Both of these cases were combinations of adenocarcinoma and adenoacanthoma.

In 1915, Ladinski described a uterine growth of this type among the cases which he cited in a paper on the "Complete Removal of Adenocarcinoma of the Uterus by Exploratory Curettage," but he made no comments on this particular type of malignancy.

The results of the microscopical examination in his case were as follows: "The material removed consisted of two fair sized masses. The larger mass consists of glandular spaces irregular in size and conformation. These spaces are lined by two or more layers of epithelium which vary from low cuboid to high cylindrical. The epithelial cells vary greatly in size, are rich in chromatin, and show few mitotic figures. In places the epithelial cells completely fill the alveoli, which are irregular in size and contour. The stroma is abundant and consists of fibrous tissue infiltrated by many round cells, and in many places distinct muscle fibers are visible. In the second specimen are a half dozen small masses the size of a millet seed. Some of these masses show solid nests of epithelial cells similar to those above described embedded in stroma resembling the stroma of uterine mucosa. In some places the lumina are so nearly filled with epithelium as to resemble a carcinoma of the solid variety."

Meigs, referred to earlier in this paper as having found one case of adenoacanthoma among 44 cases of adenocarcinoma, described the growth in this case as an epidermoid carcinoma. "The specimen showed no carcinoma in the cervix or below the internal os, yet the picture under the microscope was that of a large mass of epithelium with two or three early pearl formations." Meigs stated that this type of growth is rare and that this was the only case that had come to his notice. He thought that it was probably due to a metaplasia from the cancer cells growing in cords to a squamous epithelium, as sometimes takes place in carcinoma of the cervix. Mallory, who examined this specimen, stated that in the fundus these tumors may grow in solid alveolar or gland form.

The most complete historical review of the subject that has been published is that of Walther Schmitt (1924). He also reported a case of his own, giving a full description of the microscopical findings. His patient was a woman, aged 71 years, who following a complete hysterectomy made a good recovery. The growth which was removed measured 8 by 7 centimeters and consisted of thick plaques of pavement epithelium. It

## MECKEL'S DIVERTICULUM

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THE records of the clinic of the Harbin Hospital for a period of 20 years show that in the relative incidence of postoperative deaths from all diseases, appendicitis leads with a proportion of 24.5 per cent, the next highest percentage being for intestinal obstruction with 16.1, and that of these 16 per cent were due to Meckel's diverticulum. This record shows further that indirectly diverticula are the cause of more postoperative deaths than goiter, osteomyelitis, or hernia.

Wellington reports that 6 per cent of the cases of intestinal obstruction are caused by Meckel's diverticulum. Halstead reports 69 cases of obstruction from diverticula with a mortality of 59.1 per cent. It is evident that Meckel's diverticulum is the most serious cause of obstruction. Mortality statistics are at times indefinite in that they fail to record the cause of obstruction, and such omission tends to obscure the degree of incidence of diverticula. In other cases the variable frequency with which diverticula are found and reported is perhaps due to the fact that the surgeon fails to discover the lesion in his routine inspection in connection with an operation for some other cause. Notwithstanding our deep interest in the subject, 3 cases in our series, or 15 per cent, were not noticed at the primary operation. It would seem probable from our experience, therefore, that the majority of diverticula recorded are those that are thrust into the field of operation.

Postmortem records show in general an incidence of diverticula of about 2 per cent but the incidence reported by different surgeons varies from 0.14 to 3 per cent. The degree of incidence would probably be found to be greater in post-mortem examinations of younger subjects, but I have tried in vain to locate in medical literature reports which would confirm this statement.

While the general incidence is given at 70 per cent for males, our cases show only 35 per cent males. Bunts cites a case reported by Dowse who found a diverticulum in a woman 72 years of age. In a review of about 40 articles in the literature I found only one case, that reported by Coleman, in which diverticulum was correctly diagnosed before operation. Bettman and Blum report a case of impaction of Meckel's diverticulum that was manually relieved without excision but after recovery from operation X-ray examination

failed to reveal a diverticulum. Miles F. Porter says that Meckel's diverticulum is a greater menace to its possessor than is the diseased appendix.

If it were possible to ascertain the history of umbilical disorders in the first few weeks of infancy we would probably find that such disorders were associated with the presence of a Meckel's diverticulum which sooner or later would manifest itself. I recall the case of a boy 12 years old whose mother I attended when he was born and whom in the first 3 weeks of life I treated for a discharging sinus and a pedunculated growth of the umbilicus. He was operated upon for acute appendicitis and in the process of operating a conical band was found extending from the ileum to the umbilicus. Balfour, in a personal communication, says: "The only cases in which we have suspected Meckel's diverticulum and have found one later at the operation have been those in which there has been a history of discharge from the umbilicus."

While certain anatomical defects arising from faulty embryological development are well known, the peculiarities of the arterial supply of diverticula are not usually recognized because, so far as the circumference of the ileum is concerned, the location of the arteries varies. In 1 case in which the pouch was located laterally we were able to demonstrate that the circulation was by no means symmetrical as to the summit of the mass because increase in size was accomplished at the expense of one wall of the ileum. A clamp was placed on the mass just above the line of resection and it was found by slight incisions on the two sides that one bled while the other did not. Had excision been done at the level of the clamp the circulation would have been defective on one side. We have had two such cases ascribed to defective circulation.

The accompanying diagram (Fig. 1) shows the pouch rotated forward, clamped at S parallel to the ileum well above the line of proposed resection. After slight incisions the anterior and upper wall O bled considerably, while the posterior surface I bled from the veins and then stopped, thus indicating that the mesial line of anastomosis of the blood supply was well below the posterior incision.

No organ in the body is so liable to dysfunction as is the ileum because of the thinness of its walls,



## SYMPTOMATOLOGY

In addition to the unusual type of growth in our case and the unique location of the metastasis, the symptomatology in connection with mediastinal tumors is of interest. The usual symptoms of tumor in this region are headache, vertigo, edema, cough, dyspnea and enlargement of the superficial veins of the abdominal wall and chest. Mix states, however, that if the tumor is in the posterior mediastinum, it will produce few pressure signs until it has reached a very large size. In this case the only physical signs are possibly slight bulging of the posterior or lateral chest wall with limitation of the respiratory excursion, dullness, and increased sense of resistance, slight suppression of respiratory sounds with fairly good conductivity of the cardiac sounds. The difficulty in making the diagnosis in our case is thus readily explained. All writers on mediastinal tumors emphasize that the X rays offer the only means of reaching a definite diagnosis and urge a more careful study of the symptomatology in these cases.

## SUMMARY

A case of the rare condition of adenocarcinoma of the uterus is reported. A unique feature of this case was metastasis to the mediastinum and lung. A fairly thorough review of the literature failed to reveal any instance of this complication with the type of neoplasm under consideration.

The patient was a married woman, aged 42 years, whose symptoms and signs suggested carcinoma of the uterus. When hysterectomy was performed in 1927, the entire uterine wall was found to be invaded by carcinomatous tissue. Microscopically the growth was composed of glandular and squamous elements. Up until 2½ years after operation, there was no evidence of local recurrence.

A little more than 2 years after the hysterectomy, the patient complained of gastric pain, loss of appetite and difficulty in swallowing. There was rapid loss of weight. Physical signs in the chest suggested fluoroscopic examination, which revealed a smooth, round, sharply circumscribed mass in the mediastinum. It was thought to be a cyst but, when removed, proved to be an adenocarcinoma of the lung and posterior mediastinum, secondary to the earlier growth in the uterus. The patient made a good recovery from the operation.

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<sup>1</sup>August 1930 at time of proof reading. Patient has died since and no autopsy has been obtained.

Winslow mentions the case of a boy 12 years of age who was operated upon for acute appendicitis and 2 years later developed an acute abdominal condition caused by diverticulitis.

It is our belief that in this day of early operation surgeons generally are too conservative in searching for co existing pathological conditions. We believe that mere inspection of the gut *in situ* is not sufficient and that, while sometimes impracticable, the lower limb of the ileum should be lifted out to determine the presence or absence of diverticula. If this further investigation had been made, secondary operation would not have been necessary in the 3 following cases.

CASE 9826 Male, aged 28 years, a healthy looking farmer was admitted to the hospital October 8, 1919. He had complained 2½ days of pain in the right abdomen with vomiting and localized tenderness. He had a total leucocyte count of 22,350 and urinalysis showed considerable pus and albumin. A diagnosis of acute appendicitis was made and operation through a gridiron incision revealed a beginning necrosis of the appendix pasted to the postcecal wall. The wound was closed without drainage. The diagnosis of acute appendicitis was confirmed. No search for other lesions was made. Convalescence was painful and was attended with considerable fever. It was thought that a localized peritonitis existed. Patient was dismissed, however, on the eighteenth day without an infection of the incision. Five days later he returned to the hospital with a tentative diagnosis of intestinal obstruction which subsided in 4 days. Eleven days later he was again admitted with the same diagnosis and the pain subsided. Then he was advised to have a second operation and at this time a cone shaped diverticulum of 2½ inches was found about 2½ feet from the ileocecal valve. Resection of the diverticulum was done so as not to leave any indentation of the normal outer curve of the ileum, and the patient has remained well since. He remarked that the later pains were different from those of the acute appendicitis and that he had been subject to transient attacks of colic with vomiting for 13 years, sometimes once a month but at one time he went 2 years without symptoms. As he was a healthy man there were no other conditions that would account for his symptoms.

CASE 1372 A young unmarried woman, aged 19 years, was operated upon for a ruptured and gangrenous appendix on April 23, 1921, through a right rectus incision, with drainage. She was dismissed 17 days later. On May 1, 1921, she returned to the hospital with symptoms of obstruction which subsided on fourth day. On January 2, 1923, she was again admitted to the hospital with a postcecal abscess which was drained through a lumbar incision. She was discharged 14 days later. On July 26, 1924, she was again admitted for operation for chronic intestinal obstruction at which time numerous adhesions were noted and in their midst a Meckel's diverticulum was found buried 14 inches from ileocecal valve and pasted to the ileum. After resection of the diverticulum the incision was closed without drainage and the patient has remained free from abdominal symptoms since.

CASE 6838 A married woman, aged 36 years, 10 years previously, when single, had an appendectomy and a salpingectomy which gave her considerable relief from dysmenorrhea and abdominal pain. On February 15, 1927, she was re-admitted to hospital with a return of these symptoms and with menorrhagia. At this time she

was more or less an invalid. Operation was done and revealed dense adhesions of omentum to the ileum, caecum, and right ovary. The severing of these adhesions created considerable hemorrhage. In the mass of adhesions was found a Meckel's diverticulum about 2½ inches long and more or less tubular but expanding at its tip. The right ovary was removed and the diverticulum was resected. Convalescence and subsequent health were normal. It was easy to believe that the diverticulum in this case was the mischief maker.

As already stated the vascular supply to diverticula varies widely but under all circumstances is less than that of the ileum so that in the absence of acute conditions this lack of vitality even in the presence of adverse mechanical conditions can usually be conserved. In the presence of acute diverticulitis, however, these handicaps become greatly aggravated and for that reason offer an unfavorable field for plastic surgery.

A boy aged 20 years was operated upon on the diagnosis of acute appendicitis. A negative appendix and a somewhat pedunculated diverticulum attached to the lateral wall of the ileum were found. It is probable that one wall of the pouch had a defective blood supply with a seemingly unavoidable indentation of the outer curve of the ileum after resection. Acute obstruction developed on the third day and required resection and lateral anastomosis of the ileum. Recovery was prompt.

In another case subacute diverticulitis occurred in a girl 16 years old. A large pouch with a broad base was found adherent to the ileocecal valve and to the right tube and ovary. The pouch was resected and convalescence was uncomfortable. After this she suffered more or less for 7 months at which time she returned to the hospital with symptoms of obstruction which it operation were explained by a characteristic deformity in the presence of adhesions. Five months later she was operated upon again for obstruction. Resection of the ileum primarily would probably have saved these subsequent operations.

The technique of operation for diverticula cannot always be predicated because of the aberrant types of vascular supply to the parts in the field of operation. It is of first importance that resection should be made so as to leave the ileum in as near as possible its normal peripheral contour. The larger the base of the pouch the higher will be the level of resection, so as to allow sufficient room for the final row of interrupted sutures so that no indentation in the peripheral curve of the gut will occur. Any good method will perhaps be sufficient for the pedunculated types but if the base is broad and the diverticula is laterally located it may sometimes be better first to resect the ileum. The postoperative treatment should be modified to meet the hazard of dysfunction. In acute cases especially the postoperative treatment of diverticulitis is essentially the same as that for peritonitis—an effort should be made to minimize peristalsis so that nature can better make conservative adjustment.

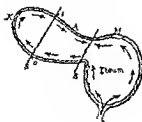


FIG 1

the multiplicity of its convolutions, and the great laxity of its mesenteric attachment. This anatomical condition can be verified by observing that a barium meal while in the ileum usually lies clumped almost entirely in the right lower abdomen and pelvis. Textbooks usually show the ileum in a middle location. These mechanical conditions contribute the greatest factor in mortality in peritonitis and obstruction. This being true it is easy to see that the presence of a distended Meckel's diverticulum, even when not definitely inflamed, increases the difficulty in that the peristaltic wave is disturbed. In the absence of other pathological conditions, this element of dysfunction can frequently be conserved for a time at least.

In one patient operated upon for a definite acute appendicitis a diverticulum was found to be distended to the size of a small pear, and, when replaced for removal of the appendix, it was again found with some difficulty because it had shrunken to what appeared like a small knuckle of ileum. This case illustrates the degree of dysfunction of ileum when encumbered with such an appendage; obviously such an attenuated structure becomes more liable to inflammatory disorders when aggravated by certain mechanical factors.

When a Meckel's diverticulum is found at operation and its presence has not been suspected previous to operation, it is usually referred to as giving symptoms or not. Such classification is obviously unreliable for abnormal conditions, especially as concerns the ileum and can hardly ever be referred to as symptomless. Therefore since diverticula alone cause symptoms, it is evident that in the presence of co-existing pathological conditions, the symptoms will become aggravated by the diverticula. This phase of the subject is of greater importance from a surgical standpoint than is usually recognized.

In our clinic the presence of Meckel's diverticulum was noted in 19 cases. In 507 consecutive laparotomies routine search was made for diverticula and their presence was noted in 7 cases, or

1.3 per cent. Of the 507 cases, operation was done in 314 for acute conditions, and in 193 elective operations were done. Of these 7 cases of diverticula, 5 were in the acute condition group and were giving evidence of causing or contributing to symptoms and 2 were in the elective group and seemed quiescent.

As to the location of the diverticula on the ileum, 30.9 per cent were peripheral, 60.1 per cent were lateral, and 28 per cent were pedunculated. The youngest patient was 3 years old and the oldest 36 years, the average age being 22 years. The pre-operative diagnosis of this series was positive in only 1 case. From this observation we are led to the conclusion that, in the majority of cases, the condition attains a state of surgical importance before the patient reaches the age of 36 years and that the 0.7 per cent remaining of the 2 per cent general incidence belong to those slighter deformities that go through life without showing trouble. None of these patients was hemorrhagic or had hernia.

A great degree of practical interest centers in the fact that 5 patients required secondary operations, in 3 cases the diverticula were overlooked in the course of other operation and in 2 cases of acute diverticulitis there was postoperative obstruction as a result of faulty technique. It should be remembered that overlooked diverticula are not an infrequent cause of failure to relieve patients who have been operated upon for other conditions. On a theoretical basis, an uncomplicated disease in the abdomen is a rare entity, for practically every major lesion carries with it certain associated pathology. Fortunately, however, removal of the major cause usually favors spontaneous recovery from these consequent transient conditions, but when we have to deal with co-existing organic pathological conditions, such as diverticula, a more serious problem is presented and if the diverticula are not removed for certain reasons a record of their presence should be made for future consideration.

Burney calls attention to the fact that operations for acute abdominal conditions frequently fail to reveal the real cause which later may be found to be a Meckel's diverticulum. Hall reported death in 2 cases of frank appendicitis in which the wounds were closed without drainage and postmortem examinations revealed acute diverticulitis. In a series of 18 cases, Coleman cites 2 in which diverticula were overlooked at appendectomy and secondary operation was necessary. In a case of salpingectomy a diverticulum was noted but was not removed, and the patient died 2 months later from obstruction.

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## SUMMARY

1 The average age of 19 patients with Meckel's diverticulum was 22 years, we believe therefore that the accepted general rate of incidence of 2 per cent would be greater if statistics were limited to the first few decades of life

2 Defective blood supply and mechanical obstacles contribute to dysfunction thus making the diseased conditions more hazardous, faulty resections at times necessitate secondary operations especially when other lesions are present

3 Overlooked diverticula are a more frequent cause of failure to relieve patients by operation than is generally supposed. The presence or absence of diverticula should be routinely noted in the operative record

4 The presence of diverticula was recorded in 13 per cent of 507 consecutive laparotomies when search was practicable and these diverticula were the cause of 10 per cent of all postoperative deaths from intestinal obstruction

5 On account of dysfunction the technique of the postoperative treatment of peritonitis should be applied to all cases of resection of diverticula

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# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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DECEMBER, 1930

### RAMBLES IN EUROPE IN 1839

**F**EW essays of one hundred years ago are as pertinent today as the day they first appeared. The following excerpts from *Rambles in Europe in 1839* by William Gibson, professor of surgery, University of Pennsylvania, are fine examples of writing of perpetual interest.

"Distant three thousand miles from the fountains of medical science and literature, how few of us have the opportunity of crossing the Atlantic and of ascertaining, personally, the exact position of writers with whose works we may be, possibly, very familiar—works we receive in six or eight weeks after publication. Yet, what do we know, in many instances, of the age, standing, or experience of the writer? He is a mere boy, perhaps, fresh from his studies, may have received a good education, is possessed of native talent, very ambitious, and determined to force himself, at once, into notice—by writing a book. Accordingly, he rakes up authorities in every direction, uses the scissors freely, manufactures cases to suit his purpose, and compiles a volume, which, not selling at home, where he is unknown, or rather known, is

shipped off to foreign parts, and too often swallowed, greedily, by those as young and inexperienced as himself. Or the work may be, really, from the pen of an experienced person, one, however, so eccentric, so peculiar in his views or notions, so full of prejudices, so connected with medical politics, or parties, so inaccurate, by nature, or from interest, in his statements, so determined to acquire a reputation by novelties, and to accomplish what the best authorities have deemed impossible, as to spare no exertions calculated to answer his end. Too many persons of each description are to be found in all parts of Europe, with whose works our public and private libraries are filled to overflowing, generally through the medium of reprints by our booksellers, all which are devoured by students, who only discover too late that their labor has been thrown away. In other words, many a man looms largely at a distance, or is well thought of, who has no reputation at home, or if so, only of equivocal, or possibly worse than equivocal, kind."

Gibson's graphic descriptions make the great surgeons of the day live and move across the pages of his book. His accounts of Liston and Velpeau furnish two excellent examples.

LISTON

"In a private room we found a respectable lady, her husband, and daughter, who, not meeting him at home, followed to the hospital to obtain his opinion respecting a cancerous mamma, and expressed strong desire to have it removed. He examined the breast very closely, and also the glands of the axilla, and finding the latter enlarged, immediately said,

## SUMMARY

- 1 The average age of 19 patients with Meckel's diverticulum was 22 years, we believe therefore that the accepted general rate of incidence of 2 per cent would be greater if statistics were limited to the first few decades of life
- 2 Defective blood supply and mechanical obstacles contribute to dysfunction thus making the diseased conditions more hazardous, fruitly resections at times necessitate secondary operations especially when other lesions are present
- 3 Overlooked diverticula are a more frequent cause of failure to relieve patients by operation than is generally supposed The presence or absence of diverticula should be routinely noted in the operative record
- 4 The presence of diverticula was recorded in 13 per cent of 507 consecutive laparotomies when search was practicable and these diverticula were the cause of 10 per cent of all postoperative deaths from intestinal obstruction
- 5 On account of dysfunction the technique of the postoperative treatment of peritonitis should be applied to all cases of resection of diverticula

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the man, and favourably impressed toward him, we took seats in his small shop and listened to his narrative 'I was the son,' said he, 'of a poor miller, and the father of my friend followed the occupation of blacksmith in the village of Breches and province of Loire, and at an early age we were both initiated in the mysteries of our paternal vocations, he shoeing horses, and I grinding grain from morning till night. In spite, however, of the severe labour to which my friend was exposed, he devoted many hours of the night to improving his mind, and twice a week attended a country school three miles off. His father's library consisted of two books—the complete drover and a volume of medical receipts—which the young blacksmith was so enamoured of as to commit to memory, and from that period turned his attention to medicine. He continued, however to shoe horses, and prescribe for their diseases until his twenty-third year, when growing tired of such labour and burning to distinguish himself in higher pursuits, proposed to me to leave our native village and repair to the Capital, where he was sure, he said, we should both meet with occupations worthy of our toil.

"With scanty means and slender wardrobes fastened to our backs, we commenced our journey on foot, and after a time reached Tours, where the money of my friend giving out, he was obliged to remain and work at his trade, while I pursued my solitary way to the Capital, and meeting with no better employment took up with the villainous business of watchmaking. Several weeks afterward my friend arrived, and hiring for three francs a black coat, which did not fit, and contrasted strangely with his country garments, waited upon the celebrated Dubois—offering to become his pupil—who, impressed favourably, notwithstanding the ludicrous figure he cut in his long-tailed coat and sky-blue panta-

loons, told him he might live among his servants and have the run of his kitchen for some weeks, until he could ascertain the nature and extent of his qualifications. The proposal was joyfully accepted, but before the expiration of the allotted time, my friend gave so many proofs of genius and talent, and worked with such assiduity and success as to astonish Dubois, and cause him henceforward to consider him as a companion and friend. From that moment the fortune of my village crony was made, for, under the excellent Dubois, he not only made astonishing progress in his medical studies, but was so diligent and untiring as to acquire in a short time such knowledge of the classics, and most of the languages of modern Europe, as to read them with facility. So much time, indeed, was devoted to all his pursuits as to render him very careless of his appearance and costume, and I remember how much mortification I experienced from perceiving that my master did not relish the occasional visits of my friend, and especially when he told me upon one occasion I ought to keep better company, for he was seriously afraid that ill-looking fellow would rob his shop. I endeavoured after this to prevail upon my old friend to attend better to his toilet, but he said such matters were beneath a man of science and proofs of a weak mind, and for his part, thought when a coat required brushing it was time to get a new one.

"Since that period only a few years have elapsed, and my country friend, farmer, and blacksmith, is now at the head of the profession in Paris, a distinguished professor and hospital surgeon, the author of large and valuable volumes in every department of the profession, and withal, a man of fortune. And where,' he continued, 'am I? Still a poor miserable watchmaker in the Palais Royal, and the tenant of this pill box of a shop, in which you are sitting.' 'And pray, Mr Jaros-



'My dear madam, do not suffer any one to touch you with the knife, let it alone and you may yet live for many years.' The lady and her friends implored him to remove it, but he remained inflexible, and said, 'If I cut it out it will return in three months, and you will die, if I let you alone you may live for a long time.' It was just such a case as many a surgeon in Europe, and in this country, would have attacked by the knife without ceremony, and it gave me a better opinion of Liston's judgment and abilities than I should have formed, under other circumstances."

#### VELPEAU

I had often heard of Velpeau as a homely, ungainly personage with grizzly hair standing up like a shoe brush, rough in his manners and careless in dress. I found him, however, polite agreeable, lively, easy, and genteel, dressed plainly but with as much neatness as most other gentlemen. He sat for half an hour conversing with great intelligence and good humour on various subjects, asked numerous questions respecting our medical men and his former American pupils whom he named and spoke of with pleasure. In returning to his numerous works, and expressing my surprise that he should find time, engaged as he was in hospital and private practice to read and quote so many English American, and other foreign books, he replied with an honesty and candour I did not expect, 'Oh, my dear sir, you see how little I know of your language, it would be impossible for me to read all these books myself but I have excellent young friends among your countrymen, and students from all parts of the world, and get them to read for me and furnish translations and extracts, and in this way appear as learned as you have been pleased to consider me.' I was delighted with this amiable frankness, and afterward took every opportunity of see-

ing him at his house and at La Charite, where he is principal surgeon. His history is an extraordinary one and calculated to make a strong impression upon a student who has experienced the hard usage and bufftings of this world as it will convince him there is no situation in life however humble, no circumstances however difficult, no misfortunes and entanglements however complicated, he may not extricate himself from and rise to the highest eminence, provided he is endowed with talent, energy, enterprise, and good conduct.

"I was walking with an old Philadelphia friend in the Palais Royal, in quest of a watch, and struck with the open and honest physiognomy of a middle aged man, whom we observed through the window so busily engaged at his work as not to perceive us, determined to enter and examine his commodities. After selecting an article of beautiful workmanship, such as we had not seen in any other establishment, demanding the price, and then, according to usage, endeavouring to get at the lowest sum, the man, with a deep sigh and most disconsolate look, said that his profession was a most unfortunate one—that for years he had toiled from morning till night poring over the wheels and springs of watches with magnifying glasses, until he had nearly put out a pair of the finest and sharpest eyes God ever made, and by long sitting had injured his limbs and impaired his constitution. 'Oh,' said he, 'that I had been a surgeon, how different might have been my situation!'" Then turning, and looking us full in the face, he continued, 'Gentlemen, I am a poor individual, without fame or consequence, but my history, inasmuch as it is connected with that of a dear friend, whose reputation is well known the world over, is nevertheless a singular and interesting one, and for his sake, if you can spare time, I will relate it to you.' Struck with the manner and earnestness of



say,' said I, 'may I ask who that friend of yours may be?' 'That friend, sir,' said he, slowly rising from his bench, putting forth his right arm, and stamping firmly with his foot upon the floor, 'That friend, sir, is no less than the celebrated Velpeau.'

"The next day I called upon Velpeau, and found him in his study behind a pile of books, which he was pitching with great vivacity from right to left, in search of authorities and quotations for a large work on surgery then in press. He showed me the translation of a letter I had sent him, at his request, detailing

the results of certain operations in my own practice, and said he had obtained similar documents from other American surgeons. Before leaving I took the opportunity to ask if Jrossay's story was correct. 'Perfectly so,' said he, 'as far as it goes, he is still my friend, an honest man, and one of the best watchmakers in Paris, of whom you may purchase without hesitation.' I returned to the Palais Royal and secured the watch, and I would commend all in quest of such articles 'to go and do likewise.'"

JOHN C. A. GERSTER

All of Gilliam's papers were clearly written and included his mistakes as well as his successes. A former student once said "Candidly he related his mistakes as well as his successes, related his mistakes in little things that we might profit by them. He knew his subject thoroughly. He was a successful teacher because he possessed the faculty of making his subject so interesting, so plain, that in whatever other branches we had our troubles, we retained in our minds a good working knowledge of obstetrics and gynecology." In his paper "The Cancer Problem" published in 1917 Gilliam said "If you are to have the co-operation of the laity, it will be necessary for you to cut out all unessentials, else they will be appalled at the complexity and take their chances with the disease."

His literary activities were not entirely confined to medical subjects. They include "Rose Croix" in 1906 "Richard Devereux" in 1915, and an unfinished work "God and Religion as Revealed in Nature."

Dr. Gilliam was gynecologist to St. Anthony's and St. Francis' Hospitals, Columbus, Ohio, member of the Columbus Academy of Medicine, the General Practitioner's Society, president of the Franklin County Medical Society, president of the Ohio State Medical Association, vice president of the American Medical Association, vice-president of the American Association of Obstetricians and Gynecologists, member of the Pan-American Medical Congress and Ninth International Medical Conference.

On October 2, 1923, Dr. Gilliam died of cerebral hæmorrhage. His work is being carried on by his son, Earl M. Gilliam, and his grandson, David B. Gilliam, both practicing surgeons in Columbus.

Surgery and humanity are greatly benefited by the efforts of Dr. Gilliam. His work lives on in hospitals throughout the world.

ROBERT ZOLLINGER

related to the diagnosis and treatment of gynecological conditions. During this time he devised a new needle and vaginal speculum. In 1900, he published his famous article on the "Designation of the Operation of Round Ligament Ventralsuspension of the Uterus."

In the *American Journal of Obstetrics* for March, 1900, Gilliam said: "On the evening of Saturday, November 18, 1889, I received a copy of the *Journal of the American Medical Association* giving a description of Ferguson's method of suspending the uterus by the round ligaments. Thirty-six hours later I did my first case, and it was during the performance of this operation that I formulated and in part carried into effect the technique described below." Dr. Gilliam gave Ferguson due credit in his first report of the operation.

Dr. Gilliam's paper on "Round Ligament Ventralsuspension of the Uterus," read at the thirteenth annual meeting of the American Association of Obstetricians and Gynecologists and abstracted in the *Philadelphia Medical Journal* for September 29, 1900, outlined the following steps in his operation:

1. A median abdominal incision three or four inches in length, and at the usual site between the umbilicus and pubes.
2. The adhesions are broken up and the fundus brought forward, after which the patient is placed in the Trendelenburg position.
3. Seize the round ligament on one side and bring it to the opening. This may be done either by the fingers or by the aid of forceps.
4. Carry a thread under the ligament at a distance of about  $1\frac{1}{2}$  inches from the uterus. The free ends of the thread are brought out of the abdomen and secured by clamped forceps.
5. The other round ligament is secured in the same way.
6. Expose the rectus muscle near the lower end of the incision by retracting its sheath and by rolling it out of its sheath on the tips of two fingers applied to the peritoneal surface under it.
7. Select a point one inch external to the margin of the incision, and something over an inch above the symphysis, through which the perforating forceps specially devised for the purpose is thrust into the peritoneal cavity. The two fingers already in the cavity guard the instrument in its passage and place the thread which surrounds the ligament within its jaws.
8. The perforating forceps is now withdrawn after removing the clamp forceps from the thread, and both thread and ligament are brought up through the perforated wound in the abdomen.
9. While the ligament is held taut, fasten it into the wound by to-and-fro catgut suture passed deeply through the ligament and including the tissues on either side.
10. Treat the opposite side in the same manner and close the median abdominal incision. Rigid observance of all the rules of aseptic surgery is essential to prevent suppuration and only a small loop of the ligament should be drawn up through the wound.

In 1903, Dr. Gilliam's first book in gynecology, entitled *A Textbook of Gynecology for Practitioners and Students*, was published. The edition was published in 1916, with his son, Earl M. Gilliam, as



*Stillantē è Phæbi panaceaam vertice monſtrat,  
Ægrotis medicam tradere doctus opem.*

*H. SUR.*

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

ALFRED BROWN M.D. F.A.C.S. OMAHA, NEBRASKA

### THE UNIVERSAL MEDICINE OF JEAN FERNEL

WITH the passing of Guy de Chauliac in the fourteenth century and Jacques Desparts (Jacobus de Partibus) in the fifteenth, medicine and surgery in France went into a decline that reduced them to almost nothing. The great schools of Montpellier and Paris lost their prominence and graduated no men that obtained any recognition. In surgery they taught barber surgeons to perform herniotomies and operate for the stone. Medicine passed into the hands of anyone who wished to practice it. The hospitals ran down until they became mortuaries or pre-mortuaries rather than hospitals. Bois eau writing of the condition of the Hotel Dieu in 1515 says: "In the infirmary which is only six fathoms (about thirty nine feet) in width there are six rows of beds, each bed about three feet wide. In each of these there are three or four patients who get in each other's way, and in the said infirmary there are seven or eight beds in which twenty five or thirty children are laid, which children are weak and delicate because of the foul air which is in the said infirmary and the majority die so that in twenty only one recovers."

This was the condition of affairs in France that confronted Jean Fernel (Joannus Fernelius) when he decided to study medicine. Not a very alluring prospect, but one of which Fernelius must have had full knowledge. It is somewhat difficult to make sure why he studied medicine, particularly as it was not the subject in which he was most interested. Gurli says he took up medicine because of family pressure brought to bear upon him. Baas thinks it was because he was not well and studied medicine to take care of his own infirmities, thus showing that he had no great opinion of the physicians of his day. In any event he had begun to study mathematics and philosophy at the College de Sainte Barbe at Paris in 1516 when he was nineteen years old. Three years later he began to teach philosophy at the college and at the same time to study medicine and in 1530 received his doctorate. During this time he had done considerable important work in mathematics and was still working on it but gave it all up to practice medicine. As the result shows in this he was wise for he became the foremost physician in France, probably because he brought to medicine a mind that considered actualities rather than theories. His studies in mathematics had trained him to work with figures which

were unalterable and his philosophical deductions had of necessity to correlate with material fact rather than abstract theory. Consequently in his work one finds little of the supernatural and mystical which was so prevalent at the time. Whether this was the reason or not, Fernelius' rise was rapid, and while still studying medicine he was called to court to care for Diana de Poitiers the mistress of the Dauphin who later became King Henry II. His treatment was successful and his patient recovered. This gave him a definite place at court and he became the real physician to the King though he did not obtain the actual appointment until 1556 when the office became vacant through the death of its holder. He was not to enjoy this prominence for long, for after going through the siege of Calais in 1557 with the King he returned with the court to Fontainebleau and died the following spring in April 1558.

Fernelius was the greatest physician France had produced up to his time. He appears to have been a most original thinker and likewise to have represented in himself two opposing types of ideas. In his medicine, so far as disease or injury are concerned, he is the mathematician dealing with fact. He believed disease is due to alterations in the component parts of the body and had nothing to do with the supernatural. In surgery, especially fracture, though he does not write much, what he does write is sound. He appears to understand fracture of the skull by *contre coup* for he advises his readers to seek elsewhere for a fracture when signs of fracture are present and it cannot be found at the site of injury. When he comes to physiology he changes to the deductive philosopher and again in large part his reasoning is sound and logical. He believed the seat of the soul is situated in the brain and the nerves of sensation come from the brain itself while those of motion arise from its membranes. He held that the elements are actual bodies and the activating principle is heat residing in them.

Fernelius was well read in the medicine of the ancients and knew their works and ideas. He quote them frequently but reserves to himself the right to assimilate the good and reject the bad with an impartiality to all, thus stamping himself as a free thinker who had broken away from the hide bound subjection to the dicta of his ancient predecessors and preferred to observe for himself and draw conclusions from his own observations.

## REVIEWS OF NEW BOOKS

**A**LTHOUGH Dr Fowler calls his text *Tonsil Surgery*<sup>1</sup> it is chiefly an anatomical study of tonsils and their adnexa. One hundred and three illustrations in two hundred eighty-eight pages help to illustrate his dissections. Some of the plates are full page and in colors. As the author states, the book is designed to aid those who seek the best type of tonsil enucleation. Of these he describes four so called classical operations, namely

- 1 Partial dissection and snare
  - 2 Automatic instruments—no dissection
  - 3 Complete dissection without snare—semi sharp
  - 4 Complete dissection without snare—sharp
- These are illustrated step for step so that one might follow them easily.

In discussing the anatomical make up of the tonsils Dr Fowler lays special stress upon the importance of the musculature especially the hundle he calls tonsillo pharyngeus which is composed of fiber of the palatopharyngeus caught in the mass of lymphoid tissue at the tonsil. It is the only muscle which is known to be attached directly to the capsule.

In addition to his anatomical studies Dr Fowler has added a chapter on the evolution of the tonsil. The text also includes instructions on postoperative care, anaesthesia, etc. Indications for removal are discussed but no new light is thrown upon the problem of determining whether or not the tonsils are causing trouble. This to the reviewer seems to be the most important problem facing the laryngologist today.

Dr Fowler's work is an excellent contribution to the anatomy of the tonsil and should be read by all men doing throat work. JOHN F DELPH

**F**OR those complacent ones who are content with the perfection of present day surgery, there is no better antidote than a consideration of surgery 100 years ago. How different from our present teachings is what was then thought by serious minded men to be perfection. Surgery can never be stationary and 100 years from now the change may be equally great.

The New York Hospital, started by royal charter in the year 1771, is the second oldest hospital in America. It has always constituted a great school of surgery.

Doctors Pool and McGowan have contributed a most instructive study of the surgical records of 100 years ago.<sup>2</sup> The cases well illustrate the surgery of the time and the comments of the authors are full of interest.

Bleeding the patient to the state of syncope was referred to as "Bleeding to deliquium animi." As much as 120 ounces of blood were withdrawn from a patient in 10 days for lightning stroke. Ten grains each of calomel and jalap every 2 hours was not thought a too heroic prescription. Yeast poultices and bread and milk poultices were employed. Surgery was done without, of course, general anaesthesia, but opium was administered. An indication that this age was pre-Listerian may be found in the teaching that reducible hernia presented no surgical indication. Of interest was the hospital rule that no operation was undertaken except after consultation by all the physicians and surgeons. Earnest efforts were made to obtain postmortem examinations.

The illustrations are exceedingly interesting and well printed. The book will make a very attractive addition to every surgeon's library.

FREDERICK CHRISTOPHER

**I**N his book on otology<sup>3</sup> Dr Keeler has departed to a degree from the orthodox form used as standard reference and text books and has added new and unusual material. A very useful chapter is the one dealing with artificial aids to hearing. Here one can find a description of the various instruments on the market and can gain an idea of what might benefit a particular case. There are also two new chapters, one dealing with "The medico-legal aspect of otology" and "The ear in life insurance examination." Many of Dr Keeler's points are illustrated by practical cases, some with both clinical and autopsy findings.

The book contains forty five chapters with ninety original illustrations and fifteen colored plates. It is printed on good stock and the type is clear.

JOHN F DELPH

**VOLUME VII** in the series of Oxford Monographs<sup>4</sup> edited by Henry A. Christian has been written by Mosenthal. Its aim is to help the practicing physician in diagnosis and treatment of variations in blood pressure and nephritis. The author reviews the present conceptions of the physiologic dynamics controlling arterial pressure and the methods for determining it. The last half of the monograph which includes the chapters on the types of increased blood pressure and essential hypertension is very ably presented and should be well taken. At the end of each chapter, there is an excellent bibliography of the current literature on the subject, and this is one of the best features of the volume.

M HERBERT BARKER

<sup>1</sup>TONSIL SURGERY. Based on a Study of the Anatomy. By Robert H. Fowler. M.D. Philadelphia. F. A. Davis. 1930.

<sup>2</sup>SURGERY at the New York Hospital ONE HUNDRED YEARS AGO. By Eugene H. Pool and Frank J. McGowan. New York. Paul B. Hoeber Inc. 1930.

<sup>3</sup>MODERN OTOTOLOGY. By Joseph Clarence Keeler. M.D. F.A.C.S. Philadelphia. F. A. Davis Company. 1930.

<sup>4</sup>OXFORD MONOGRAPHS ON DIAGNOSIS AND TREATMENT. Edited by Henry A. Christian. M.D. Sc.D. LL.D. Vol. VII.—THE DIAGNOSIS AND TREATMENT OF VARIATIONS IN BLOOD PRESSURE AND NEPHRITIS. By Herman O. Mosenthal. M.D. New York. Oxford University Press. 1930.





# SUBJECT INDEX TO VOLUME LI

- ABSCESSES**, perinephritic, 674  
**Acetabulum** Congenital dislocation of the hip, operation for defective, 249  
**Fractures of**, 387  
**Adam, Hungarian surgery**, ed 420  
**Adenocarcinoma**, of uterus, with metastasis to posterior mediastinum and lungs, 830  
**Alcohol injection**, Elimination of pain in obliterative vascular disease of the lower extremity, technique for alcohol injection of sensory nerves of lower leg, 394  
**Alkali reserve**, Effects of sodium amytal on liver function, rate of secretion and composition of urine, reaction, and concentration of blood, and body temperature, 356  
**American College of Surgeons**—  
 Clinical Congress ed 10, 143, 276, 435, 575  
 Committee on Treatment of Malignant Diseases, Cancer clinics, ed 561, Organization of service for diagnosis and treatment of cancer, recommended by the committee, 570  
 Committee on Treatment of Fractures, Increasing incidence of fractures, ed 561  
 Retrospect and prospect, ed 10  
 Surgical Dressings Standardization of 273  
**American Medical Association**, Increasing incidence of fractures ed 561  
**American Society for the Control of Cancer**, Cancer clinics, ed 561  
**American Surgical Association**, Twenty five years of Surgery, Gynecology and Obstetrics, ed 3  
**Anesthesia** Changes in the spinal fluid following injection of spinal anesthesia, 76, Obstetrical analgesia, further study based on more than twenty thousand cases, 190  
 Useful semi anesthesia from luminal, 217  
 Uranostaphylorrhaphy, 224, Sodium amytal nitrous oxide, for thyroidectomy, 352  
 Effects of sodium amytal on liver function, rate of secretion and composition of the urine, reaction, alkali reserve, and concentration of blood, and body temperature, 356  
 Tribromethyl alcohol (avertin), 301, Art of surgery, 479  
 Vaginal hysterectomy under local anesthesia, 484  
**Anatomy**, Surgical Larynx as related to surgery of the thyroid based on anatomical study, 449, Study of tendon sheaths of foot and their relation to infection 460  
**Ankle**, Mechanical and anatomical principles of operations for drop foot suggested new operations, 252  
**Anomalies** Operations on solitary kidneys and ureters, report of fifty two cases, 836, Meckel's diverticulum, 863  
**Appendix** Opinion on present high operative mortality in acute appendicitis 570  
 Roentgenology of, 810  
**Arm**, Principles of treatment of non union of fracture, 289  
**Asepsis** A bacteriological study of the value of mercurchrome as a vaginal antiseptic with particular reference to its use in obstetrical cases, 345  
 Art of surgery, 479  
**Avertin**, Tribromethyl alcohol anesthesia, 361  
**Axilla**, Method of reconstruction of for contracture, 703  
**BAKAY**, Hungarian surgery ed 420  
**Barbituric acid compounds** Useful semi anesthesia from luminal 17  
**Bile ducts**, Obstructive jaundice 944  
**Bite infections** Human of hand 1  
 study of routes of extension of infection from the dorsum of hand 591  
**Bladder**, urinary, Significance of renal counterbalance in renal surgery, with reference particularly to treatment of unilateral and bilateral hydro angular ureters and hydronephrosis with description of operation for this condition, 237, Resection of presacral nerve in treatment of cord, preliminary report, 404, Angioma of, 541, Cystitis emphysematosa, report of three additional cases in women, 545  
**Blood**, concentration of, Effects of sodium amytal on liver function, rate of secretion and composition of urine, reaction alkali reserve, and body temperature, 356, Calcium partition in pregnancy, parturition, and the toxemias, 469, menstrual, Cyclical changes in vaginal mucous membrane, 848  
**Blood pressure** Brain flap, its relation to intracranial pressure, 65  
**Blood vessels**, Varicose veins and their treatment by the injection method, 169, Elimination of pain in obliterative vascular disease of lower extremity, technique for alcohol injection of sensory nerves of lower leg, 394, Larynx as related to surgery of thyroid based on anatomical study, 449, Blood supply of human para thyroids, 805  
**Bone**, Senility of, and its relation to bone repair, 42, Osteochondritis of growth centers, 145  
**Bottomley, John T** 266  
**Brain**, Experimental study of effects of depressed fractures of skull, 17, Anatomical study of subdural hemorrhage associated with tentorial splitting in the newborn, 31, Brain flap and its relation to intracranial pressure, 65  
**Brain flap**, Its relation to intracranial pressure, 65  
**Breast**, Surgery, radium, or a combination of both in treatment of cancer, ed 563, Intrathoracic new growths, results of surgical treatment in twenty four cases, 647  
**Bronchi** Intrabronchial drainage, its importance in the diagnosis and treatment of pulmonary suppurations, 115  
**Bronchiectasis** Intrabronchial drainage, its importance in diagnosis and treatment of pulmonary suppurations 115  
**Bronchitis**, Respiratory complications and the surgical patient 798  
**Budapest**, Hospitals and University of, ed 420  
**Burn** contractures, Method of reconstruction of axilla for, 705  
**Burn scars**, Development of cancer in, analysis and report of thirty four cases, 749  
**CALCIUM** partition, in pregnancy, parturition, and the toxemias, 469  
**Cancer**, Again the cancer problem, ed 262, clinics ed 561, Surgery, radium, or a combination of both in treatment of cancer, ed 563, Organization of service for diagnosis and treatment of cancer, recommended by Committee on Treatment of Malignant Diseases, American College of Surgeons, 570, Use of electrocautery on normal tissue, 607, Karo burn, Development of cancer in burn scars, analysis and report of thirty four cases 740  
**Cancer clinics**, ed 561, Organization of service for diagnosis and treatment of cancer, recommended by

IN a volume of 472 pages reprinted from the *Frankfurter Zeitschrift fuer Pathologie* is brought together the work upon the gas treatment, the chemistry, and the physiology of malignant tumors which has been done by Professor Bernhard Fischer, Wasels in the Senckenberg Institute of Pathology, of the University of Frankfurt.<sup>1</sup> Malignant tumor cells differ from normal cells in many significant ways, here fully discussed, among which are their greater susceptibility to injury and their peculiar metabolism and respiration. In an effort to discover a means of destroying malignant tumor cells, the

<sup>1</sup>DIE GASBEHANDLUNG BOESARTIGER CRESCENZLESEN. By Dr Bernhard Fischer Wasels in collaboration with Dr W. Buegerling Dr J. Heeren Dr S. Heinsheimer Dr G. Joss. Munich J. F. Bergmann 1930

authors have used a gas mixture composed of 5 per cent carbon dioxide and 95 per cent oxygen. It is claimed that this mixture can be inhaled for several hours daily without danger. Numerous experiments with this gas mixture on cancer bearing mice and its use in two human patients alleged to have carcinoma of the stomach and esophagus, respectively, are reported, and diminution in the size of the tumors and clinical improvement are claimed. The technique of this treatment is described in detail. The work is admittedly experimental, but the volume contains a great deal of very interesting and important information and is well worth reading with a critical attitude of mind.

J. P. SIMONDS

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Iodized oil, Lipiodol pelvic cysts, 55, Intrabronchial drainage, its importance in diagnosis and treatment of pulmonary suppurations, 115

**J**AUNDICE, Obstructive, 844

Joint, Chondromatosis of joint capsule, 99

Jones, John, 740

**K**IDNEY, Pyeloscopy, radiology of, clinical and experimental study, 50, Renal resection, experimental study of postoperative function, 213, Significance of renal counterbalance in renal surgery, with reference particularly to treatment of unilateral and bilateral hydro angular ureters and hydronephrosis with a description of an operation for this condition, 237, Intravenous urography, 404, Intravenous urography, ed 421, Intravenous urography in diagnosis of urological diseases in childhood, 409, Perinephritic abscess, 674, Resection of renal pelvis for hydronephrosis, complications and results, 717, Operations on solitary kidneys and ureters, report of fifty two cases, 836

Knee, Chondromatosis of joint capsule, 99, Injuries to semilunar cartilages of, 720

**L**ABOR, Obstetrical analgesia, further study based on more than twenty thousand cases, 190, Bacteriological study of value of mercurochrome as vaginal antiseptic with particular reference to its use in obstetrical cases, 345, Calcium partition in pregnancy, parturition, and the toxemias, 469, Diagnosis of contracted pelvis by impression method, 852

LaChanté, Rambles in Europe, in 1839, ed 869

Larynx, as related to surgery of thyroid based on an anatomical study, 449

Leg, Hemorrhage and shock in traumatized limbs experimental study, 196, Principles of treatment of non union of fracture, 289, Elimination of pain in obliterative vascular disease of lower extremity, technique for alcohol injection of sensory nerves of lower leg, 394, Surgery of diabetes as it concerns gangrene of lower extremities and carbuncles, 700

Leucorrhœa, Trichomonas vaginalis vaginitis, common cause of leucorrhœa, 552

Ligament, Mackenrodt, Technique of total hysterectomy 491, Injuries to semilunar cartilages of knee joint, 720

Ligatures, Art of surgery, 479

Lip Mirault operation for single harelip, 81, Surgery, radium or a combination of both in treatment of cancer of, ed 563

Lipiodol pelvic cysts, 55, Intrabronchial drainage, its importance in diagnosis and treatment of pulmonary suppurations, 115

Liver, Effects of sodium amytal, on liver function rate of secretion and composition of urine, reaction, alkali reserve, and concentration of blood, and body temperature, 356, atrophy ed 737

Lumbosacral joint, Operative measures in treatment of affections of and sacro iliac articulation, 381

Luminal, Useful semi anesthesia from, 217

Lungs Intrabronchial drainage, its importance in diagnosis and treatment of pulmonary suppurations, 115, Influence of transverse upper abdominal incision on incidence of postoperative pulmonary complications, 208

Lung, Postoperative pulmonary complications, ed 264, Intrathoracic new growths, results of surgical treatment in twenty four cases, 647, Respiratory complications and the surgical patient, 798, Adenocanthoma of uterus with metastasis to posterior mediastinum and 856

**M**ANNINGER, Hungarian surgery, ed 420

Marjolin, Jean Nicolas, Development of cancer in burn scars, an analysis and report of thirty four cases, 740

Master Surgeons of America—Francis John Shepherd, 138, John T. Bottomley, 266, Marcus Whitman, correction, 419, Charles Andrew Powers, 424, John Munro Elder, 565, John Jones, 740, David Tod Gilliam, 873

Meckel's diverticulum, 863

Mediastinum, Adenocanthoma of the uterus, with metastasis to the posterior mediastinum and lungs, 856

Membrane, periduodenal, Periduodenitis, 840

Mercurochrome, Bacteriological study of value of, as vaginal antiseptic with particular reference to its use in obstetrical cases, 345

Methods, impression of Hillis, Diagnosis of contracted pelvis, 852

Micturition, Resection of presacral nerve in treatment of cord bladder, preliminary report, 494

Morbidity, Control of, and mortality following pelvic surgery, review of one thousand consecutive personal cases, 522

Mortality, Control of morbidity and, following pelvic surgery, review of one thousand consecutive personal cases, 522, Opinion on present high operative, in acute appendicitis, 529

Mouth, Surgery, radium, or combination of both in treatment of cancer ed 563

Mucous membrane of mouth, Again the cancer problem, ed 262

Muscle gluteal, Mechanism of gluteal gait, 727

Mucosa vaginae Cyclical changes in vaginal mucous membrane, 848

**N**ECROSIS following cautery excision, Effects of electrocautery on normal tissues, 667

Nerve roots, spinal, Study of hypertrophic osteo arthritis of spine, 732

Nerves, sensory of leg, Elimination of pain in obliterative vascular diseases of lower extremity technique of alcohol injection, 394, recurrent laryngeal, Larynx as related to surgery of thyroid based on anatomical study, 449, presacral, Resection of in treatment of cord bladder, preliminary report, 494

Nervous system, Cystic dermoid tumor of spinal cord, 162

Nose, Mirault operation for single harelip, 81

**O**BSTETRICS, Obstetrical analgesia, further study, based on more than twenty thousand cases, 190, Bacteriological study of value of mercurochrome as vaginal antiseptic with particular reference to its use in obstetrical cases, 345, Diagnosis of contracted pelvis by impression method, 852

Esophagus, Surgical management of pharyngo esophageal diverticulum based upon an operative experience with twenty one cases, 227, Diaphragmatic hernia associated with traumatic gastric erosion and ulcer, 504

Old Masterpieces in Surgery—The collected works of Zacutus Lusitanus, 141, The collected works of Jerome Capivaccus, 268, The bleeding manual of Augustus, 429, The surgery of Pieter Van Foreest, 567, Jan Van Heurne, 744, The universal medicine of Jean Fernel, 876

Operation, Mirault for single harelip, 81, Russell's, Indirect inguinal hernia, Some observations on Russell's theory and technique, 133, Pauchet's groove resection, Surgical treatment of ulcers of superior third of stomach, 367, Billroth I, resection of stomach, 378

IN a volume of 472 pages reprinted from the *Frankfurter Zeitschrift fuer Pathologie* is brought together the work upon the gas treatment, the chemistry and the physiology of malignant tumors, which has been done by Professor Bernhard Fischer Wascels in the Senckenberg Institute of Pathology of the University of Frankfurt. Malignant tumor cells differ from normal cells in many significant ways here fully discussed, among which are their greater susceptibility to injury and their peculiar metabolism and respiration. In an effort to discover a means of destroying malignant tumor cells, the

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Pathological fractures, 131, Mechanical and anatomical  
principles of operations for drop foot, suggested new  
operations, 252
- Toes Study of tendon sheaths of foot and their relation to  
infection, 460
- Tongue, Surgery, radium or a combination of both in  
treatment of cancer, ed 563
- Tonsillectomy, Postoperative pulmonary complications,  
ed 264
- Tribromethyl alcohol, avertin anesthesia, 361
- Trichomonas vaginalis vaginitis, common cause of leucor-  
rhœa, 552
- Tuberculosis, Intrabronchial drainage in diagnosis and  
treatment of pulmonary suppurations, 115
- Tumor, Angioma of bladder, 541
- Twenty fifth anniversary of Surgery, Gynecology and Ob-  
stetrics, ed 3

- ULCLER, Marjolin's, Development of cancer in burn  
scars, analysis and report of thirty four cases, 749
- Ulna, Pathological fractures, 131
- Uranostaphylorrhaphy, 224
- Ureter, Significance of renal counterbalance in renal  
surgery with reference particularly to treatment of  
unilateral and bilateral hydro angular ureters, and  
hydronephrosis with description of an operation for  
this condition, 237, Intravenous urography, 404,  
Intravenous urography in diagnosis of urological  
diseases in childhood 409, Intravenous urography, ed  
421, Resection of renal pelvis for hydronephrosis, its  
complications and results, 711, Operations on solitary  
kidneys and ureters, report of fifty two cases, 836
- Urethra, Urethral caruncle in female, 61

- Urine, Effects of sodium amytal on liver function, rate of  
secretion, and composition of urine, reaction, alkali  
reserve and concentration of blood, and body tem-  
perature 356
- Urography, Intravenous 404 Intravenous, in diagnosis of  
urological diseases of childhood 409, Intravenous, ed  
421
- Uroselectan Intravenous urography, 404, Intravenous  
urography in diagnosis of urological diseases in child-  
hood 409, Intravenous urography, ed 421
- Uterus, bicornis unicollis Lipiodol pelvic cysts, 55,  
Primary and secondary ovarian cancer, histogenetic  
morphological, and clinical study, 321, Vaginal  
hysterectomy under local anesthesia, 484, Technique  
of total hysterectomy 491, Sarcoma of the cervix,  
500, Trichomonas vaginalis vaginitis, common cause  
of leucorrhœa, 552 Surgery, radium, or combination  
of both in treatment of cancer, ed 563, Adeno-  
acanthoma of uterus with metastasis to posterior  
mediastinum and lungs 856

- VAGINA, Bacteriological study of value of mercuro-  
chrome as vaginal anti-septic with particular reference  
to its use in obstetrical cases, 345, Sarcoma of cervix,  
500, Trichomonas vaginalis vaginitis, common cause of  
leucorrhœa 552 Cyclical changes in vaginal mucous  
membrane, 848

- Varicose veins, and their treatment by injection method,  
109

- Velpeau, Rambles in Europe in 1839, ed 869
- Verhely, Hungarian surgery, ed 420

- WHITMAN, Marcus, cor 419  
Winteritz, Hungarian surgery, ed 420

Osteochondritis of growth centers 145

Ovary, Hernia of and fallopian tube record of twenty five cases 266 Primary and secondary ovarian cancer, histogenetic morphological and clinical study, 321, Vaginal hysterectomy under local anesthesia 484 Sarcoma of the cervix 500

**PANCREAS** Acute pancreatitis 183

Parathyroid Blood supply of human 803

Parotid gland Tumors of study of two hundred twenty five cases with complete end results in eighty cases, 626

Parturition, Calcium partition in pregnancy parturition and toxemias 469

Pelvis Mechanism of gluteal gait, 727 Diagnosis of contracted by impregnation method 832

Peter Pázmány Hungarian surgery ed 420

Pharynx, Surgical management of pharyngo-oesophageal diverticulum, based upon operative experience with twenty-one cases 227

Pneumonia Influence of transverse upper abdominal incision on incidence of postoperative pulmonary complications 208 Respiratory complications and the surgical patient 793

Polomyelitis Mechanism of gluteal gait 727

Pólya Hungarian surgery ed 420

Powers Charles Andrew 424

Pregnancy Calcium partition in parturition and toxemias 469 Aschheim Zondek reaction for results in 100 cases 476 Therapy of puerperal infection 557

Puerperal infection Therapy of 557

Pyeloscopy Radioscopy of the kidney pelvis clinical and experimental study 50

**RADICULAR** syndrome Study of hypertrophic osteoarthritis of spine 731

Radioscopy Pyeloscopy of kidney pelvis clinical and experimental study 50

Radium Surgery and combination of both in treatment of cancer ed 563

Radius Pathological fractures 131

Reaction Aschheim Zondek for pregnancy results in one hundred cases 476

Rectum Carcinoma of study of three hundred three cases 783 Two-stage abdominoperineal removal of cancer of 692

Rib resection Thoracoplasty retractors 556

Roentgenology of appendix 810

Roentgenography lipiodol pelvic cysts 55

Roentgen therapy Control of morbidity and mortality following pelvic surgery review of one thousand consecutive personal cases 522

**SACRO ILIAC** joint Operative measures in the treatment of affections of the lumbosacral and sacro-iliac articulation 381

Scalp, Again the cancer problem ed 262

Scars Development of cancer in burn analysis and report of thirty four cases 749

Senility, of bone and its relation to bone repair 42

Shepherd Francis John 138

Shock Haemorrhage and in traumatized limbs an experimental study, 196

Sigmoid, Carcinoma of rectum study of three hundred three cases 783

Skeletal traction Plaster imbedded use in treatment of fractures 854

Skene glands Urethral caruncle in female 61

Skin, Again the cancer problem, ed 262 Development of cancer in burn scars, analysis and report of thirty

four cases 749 transplantation Method of reconstruction of axilla for Contracture 705

Sodium iodide Intravenous urography, ed 421

Sodium amylal Effects of, on liver function rate of secretion and composition of urine reaction alkali reserve and concentration of blood, and body temperature 356 Nitrous oxide anaesthesia for thyroidectomy 352

Spina bifida occulta report of two cases 537

Spinal cord, Cystic dermoid tumor of, 162, Spina bifida occulta report of two cases 537

Spinal fluid content Changes in, following injection for spinal anaesthesia 76

Spinal fluid sugar Changes in, following injection for spinal anaesthesia 76

Spine Osteochondritis of the growth centers 145 Operative measures in treatment of affections of lumbosacral and sacro-iliac articulation 381 Spina bifida occulta report of two cases, 537, Study of hypertrophic osteoarthritis of, 731

Spleen Puncture of report of twenty seven cases 258

Statistics Evaluation of, ed 135

Stomach Duodenal niche criterion in healing of duodenal ulcer 109 Carcinoma and tuberculosis of report of case with review of literature 245 Again the cancer problem ed 262 Surgical treatment of ulcers of superior third groove resection 367, Billroth I resection of 378 Diaphragmatic hernia associated with traumatic gastric erosion and ulcer, 504 Periduodenitis 840 Obstructive jaundice 844

**SURGERY GYNECOLOGY AND OBSTETRICS** Twenty five years of ed 3 Origin of journal and development of its editorial policy ed 5 On the business side ed 8, retrospect and prospect ed 10

Surgery American Twenty five years of **SURGERY GYNECOLOGY AND OBSTETRICS** ed 3 Influence of transverse upper abdominal incision on incidence of postoperative pulmonary complications 208 Useful semi-anaesthesia from luminal 217, Postoperative pulmonary complications ed 264 Standardization of surgical dressings 273 in Hungary ed 430 Art of 479 Control of morbidity and mortality following pelvic review of one thousand consecutive personal cases 522 Opinion on present high operative mortality in acute appendicitis 59, radium or combination in treatment of cancer, ed 563 in diabetes as it concerns gangrene of lower extremities and carbuncles 700 Respiratory complications and surgical patient, 793 Surgical dressings Standardization of 273

Sutures Art of surgery, 479

**TALUS** Mechanical and anatomical principles of operation for drop foot, suggested new operations 252

Tendons of foot Study of tendon sheaths of foot and their relation to infection 460

Tests Aschheim Zondek reaction for pregnancy results in one hundred cases, 476

Tetany, Treatment of postoperative with special reference to administration of irradiated ergosterol 823

Thigh Principles of treatment of non union of fracture 289 Thoracoplasty retractors 556

Thorax, Intrathoracic new growths results of surgical treatment in twenty four cases 647

Thyroid, Recurrent and persistent hyperthyroidism ed 136 Larynx related to surgery of based on anatomical study 449 Blood supply of human parathyroids 805

Treatment of postoperative tetany with special reference to administration of irradiated ergosterol 823

Sodium amylal nitrous oxide anaesthesia for thyroidectomy, 352

BOOK REVIEWS

- American Gynecological Society A Syllabus of Lectures on Obstetrics for Nurses, 142
- BECHMAN, HARRY Treatment in General Practice, 745
- BÉCLÈRE, CLAUDE La Perméabilité et les Obturations Tubaires, Stérilité, Infections Salpingiennes Chirurgie Tubaire, 431
- BEILIN, DAVID S Gall bladder Disease, Roentgen Interpretation and Diagnosis, 568
- BERKELEY, COMYNS Gynecology for Nurses and Gynecological Nursing, 747
- BOURNE, GEOFFREY, and STONE, KENNETH The Principles of Clinical Pathology in Practice a Guide to the Interpretation of Laboratory Investigation for the Use of Those who Are Engaged in the Practice of Medicine, 269
- BUCKY, GUSTAV Grenz Ray Therapy With contributions by Dr Otto Glasser and Dr Olga Bicker Manheimer Translated by Walter James Highman, 568
- CAMPBELL, WILLIS C A Text Book on Orthopedic Surgery, 745
- CECIL RUSSELL L Oxford Monographs on Diagnosis and Treatment Edited by Henry A Christian Vol VI—The Diagnosis and Treatment of Arthritis 270
- COLP RALPH, and KELLER MANELVA WYLIE Textbook of Surgical Nursing 269
- DAVIES, H MORRISTON Surgery of the Lung and Pleura, 746
- FARR, ROBERT FIMMETT Practical Local Anesthesia and Its Surgical Technique 2d ed rev, 142
- FISCHER WASELS, BERNHARD Die Gasbehandlung Boesartiger Geschwulste In collaboration with Dr W Buengler, Dr J Heeren, Dr S Heinsheimer, and Dr G Joos, 878
- FOWLER, ROBERT H Tonsil Surgery, Based on a Study of the Anatomy, 877
- FRIEDENWALD, JONAS S The Pathology of the Eye, 270
- GELLHORN, GEORGE Gynecology for Nurses 432
- GOLDBACHER, LAWRENCE Hemorrhoids, the Injection Treatment and Prunus Ani, 432
- GOLDZIEHER MAX A The Adrenals, Their Physiology, Pathology, and Diseases, 430
- GOULD, SIR ALFRED PEARCE Elements of Surgical Diagnosis Revised by Erick Pearce Gould, 568
- Handbuch der Urologie Edited by A von Lichtenberg, F Voelcker, H Wildbolz Vols III and IV Spezielle Urologie I and II, 142
- Handbuch der Gynaekologie Edited by W Stoeckel Vol I first half Anatomie und topographische Anatomie Entwicklungsgeschichte und Bildungsfehler der weiblichen Genitalen, 748
- HARPER, PAUL T Clinical Obstetrics, 432
- JACKSON, CHEVALIER, and COATES, GEORGE MORRISON The Nose Throat, and Ear and Their Diseases, in Original Contributions by American and European Authors, 269
- JELLETT, HENRY, and MADILL, DAVID G A Manual of Midwifery, for Students and Practitioners 4th ed, 433
- JOLY, J SWIFT Stone and Calculus Disease of the Urinary Organs, 271
- KEELER, JOSEPH CLARENCE Modern Otolaryngology, 877
- KIDD, FRANK, and SIMPSON, A MALCOLM Common Infections of the Female Urethra and Cervix Additional chapters by George T Western and M S Mayou 2d ed, 431







- VOELCKER F, WILDBOLZ H, and LICHTENBERG A von Wildbolz H, Lichtenberg A von and Voelcker F  
 Handbuch der Urologie Vols iii and iv Spezielle Handbuch der Urologie Vols iii and iv Spezielle  
 Urologie 1 and ii, 142 Urologie 1 and ii, 142
- WHITE H P WINSBURY Stone in the Urinary Tract, 433 WRIGHT, S. G. Applied Physiology 3d ed, 746